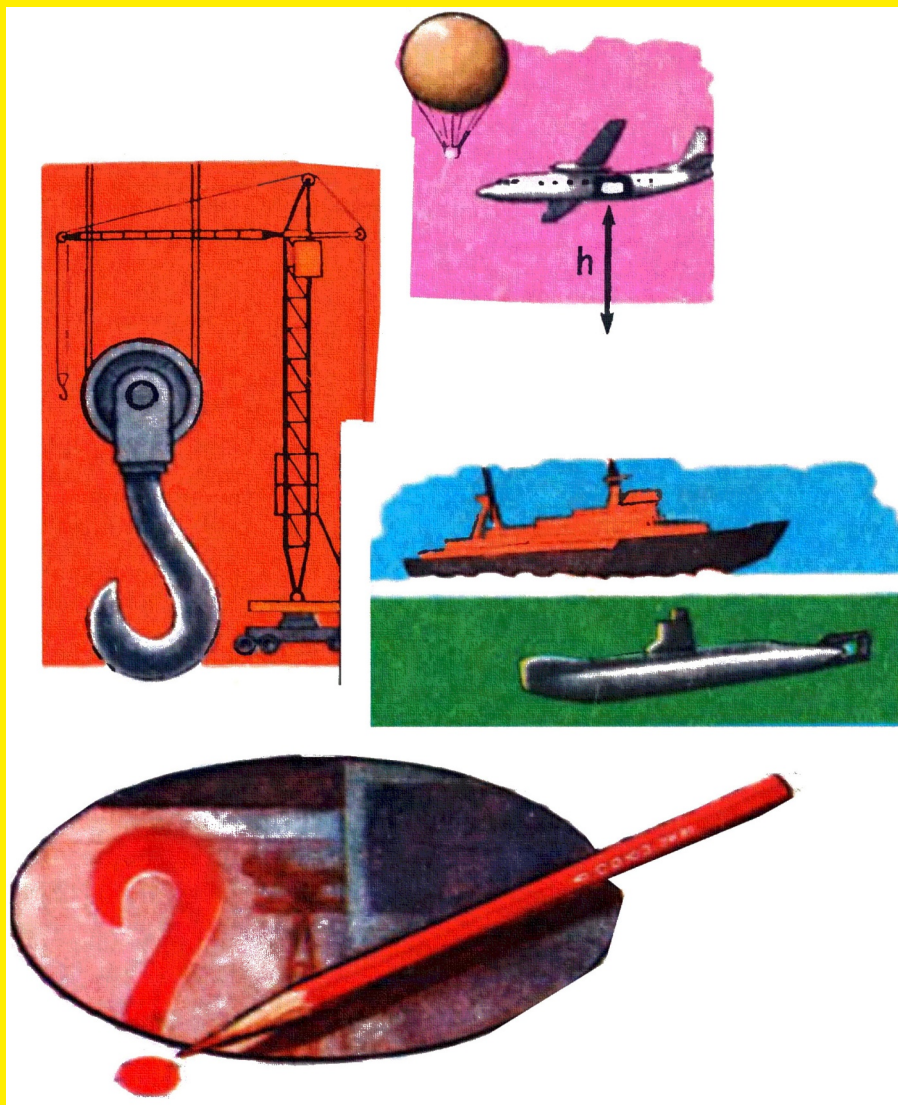




PHYSICS

in Pictures

N.S. Bezchastnaya

ANNOTATION

This book for extracurricular reading includes picture-problems for the 6th–7th grade physics course, reflecting physical phenomena and their application in technology and everyday life. Such picture-problems develop students' powers of observation and teach them to independently analyse and explain the phenomena around them by applying the knowledge gained in their lessons. Answers are provided at the end of the manual.

N.S. Bezchastnaya

Physics in Pictures

Translated from the Russian

by

Damitr Mazanav

The Mir Titles Project 2025

Originally published in Russian by "Prosveshcheniye"
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Translated from the Russian and typeset by
Damitr Mazanav

Released on the web by in 2025

The Mir Titles Project <https://mirtitles.org>

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Translators Note

This little book has fantastic way of identifying, appreciating and understanding physics in the real world. When I chanced upon this book, I could not but resist translating it immediately. The total effort taking about two days. I hope this book does help you appreciate physics in the real world.

Damitr Mazanav

Dear Readers!

The whole world around us, nature and technology, is filled with all sorts of physical events, which are governed by physical laws. It is necessary to learn to recognise physical events, understand how and why they occur, what conditions affect them, and what consequences they lead to.

Learn to observe. In the city, by the sea shore, in the forest or field—everywhere you may have many interesting and varied questions. Notice everything, remember it, write it down. Seek answers to the questions that arise, they will be useful to you in your studies and later life. Do not be embarrassed if at first it is difficult for you to distinguish and understand this or that event that occurs in the surrounding world in different circumstances. Look for physical events carefully, over time you will learn to see them everywhere, always, in everything.

This book will help you spot and understand a whole series of events that take place right in front of everyone all the time, and so they often do not catch our attention. It will help you learn to compare physical events, find common features and individual traits in them, and match real life with the material you study in your textbook.

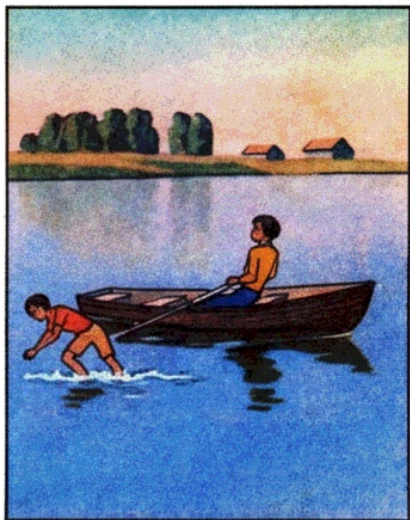
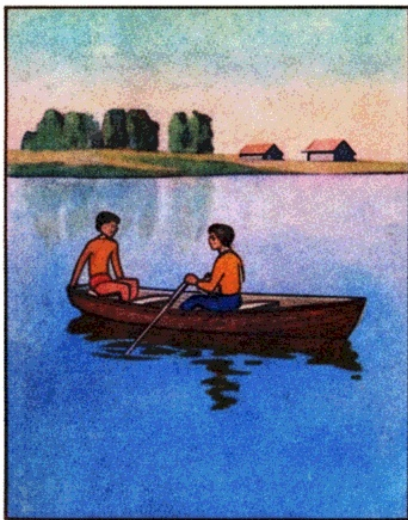
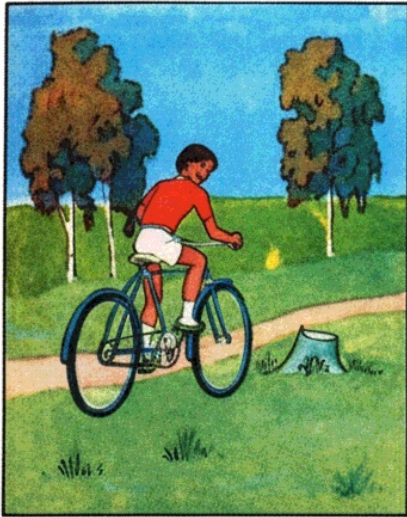
The goal of the book is to show the variety of physical events in nature and technology. It will show how important it is to recognise them, observe and study them, so as to understand the laws of nature and consciously apply them in your future activities.

Physics is a great science. By discovering and helping to master the forces of nature, it shows how they can be directed for the good of mankind. The book will suggest what to do in a free minute, what to look at, what to remember, and which of the events you meet in everyday life should be checked by experiment.

To be able to use the riches of nature, you must treat nature very carefully and constantly protect it.

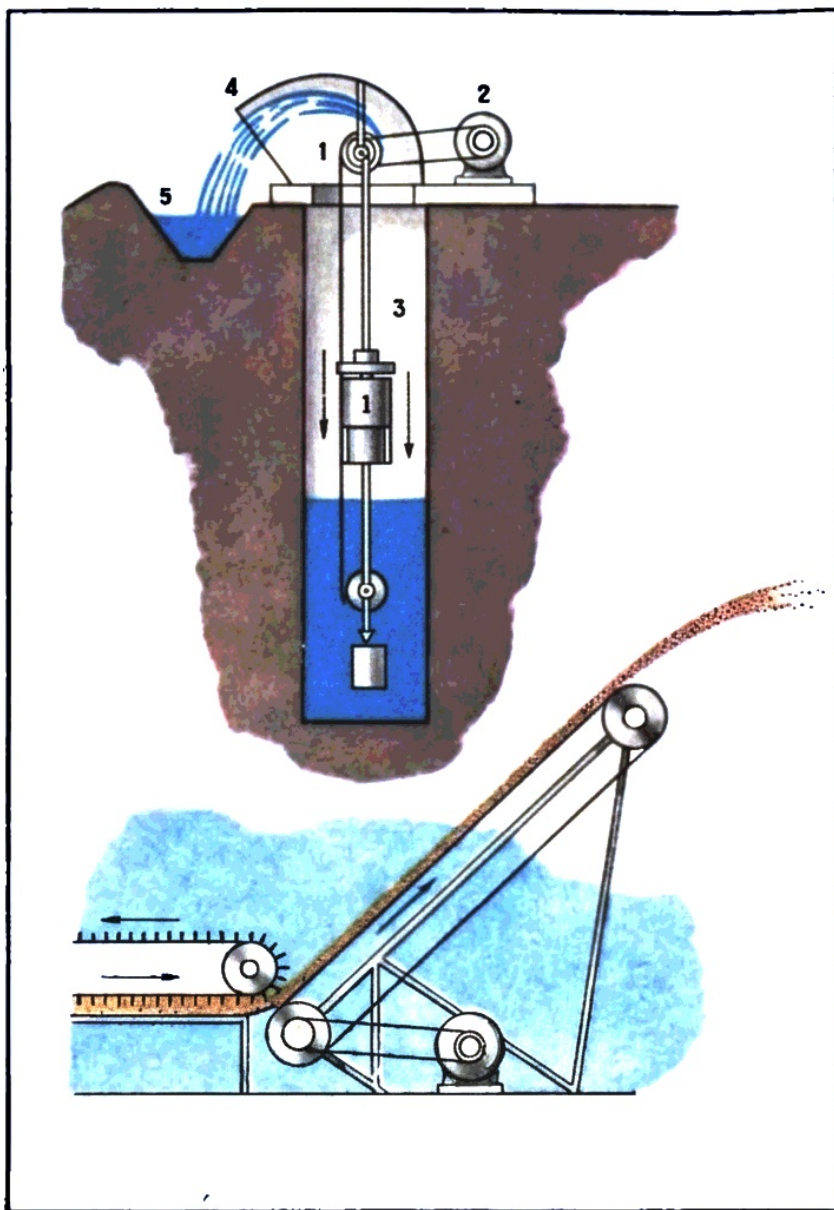


1 Which of the athletes will reach the finish line first under otherwise equal conditions and why?

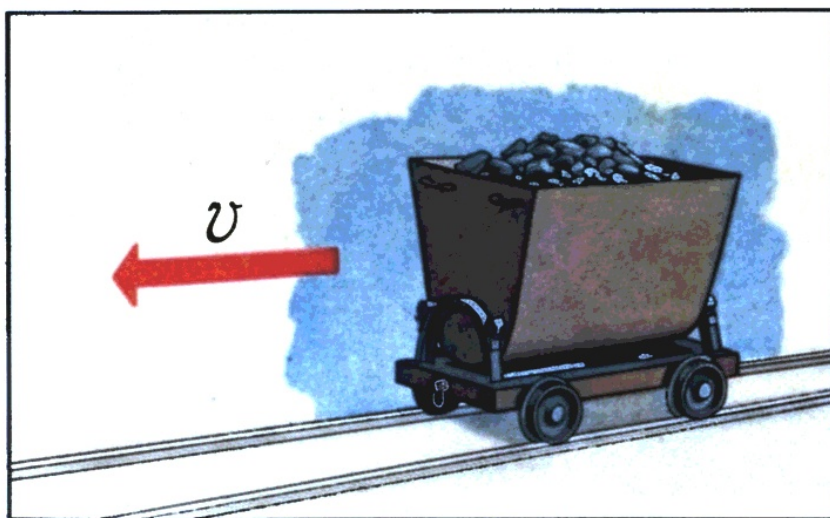
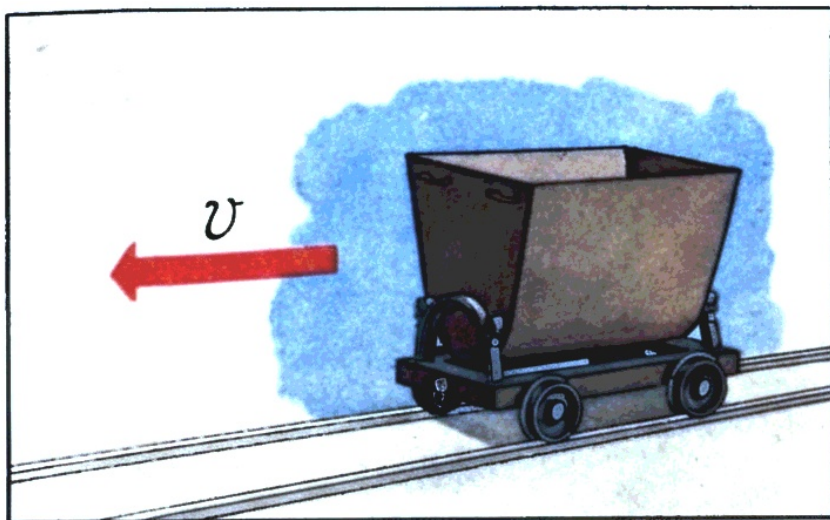


2

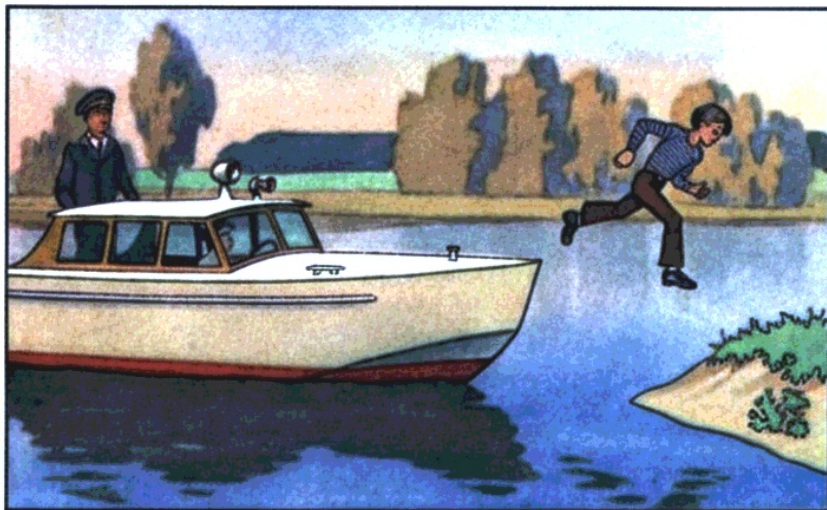
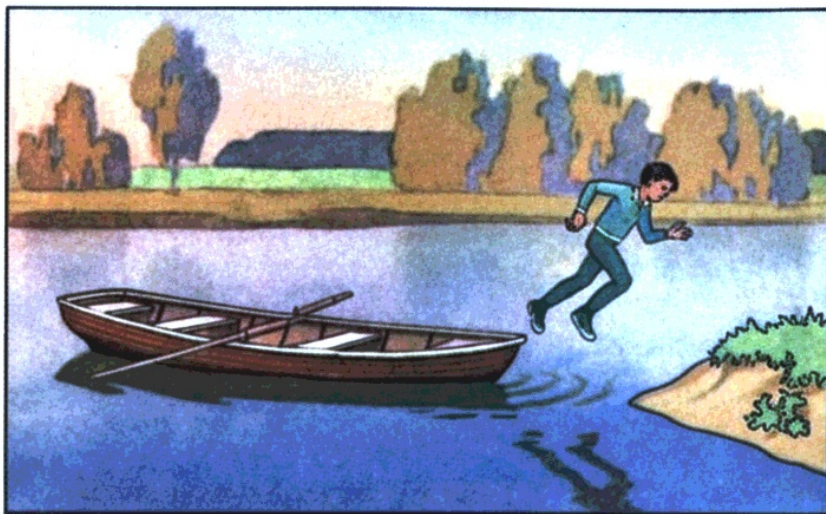
What physical phenomenon do you observe in the illustrations shown? Explain.



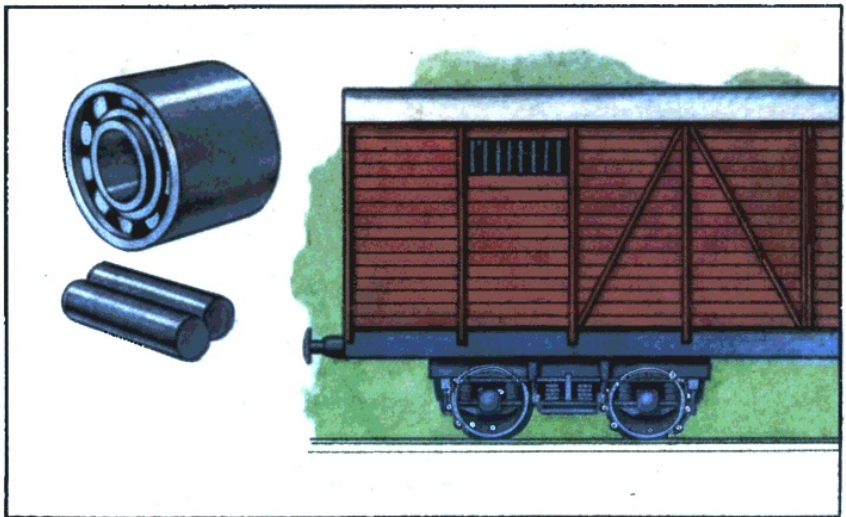
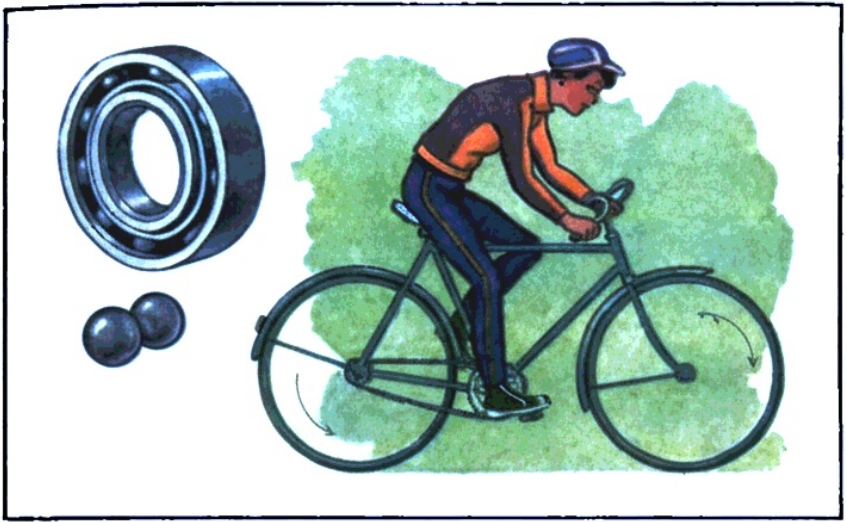
3 Based on what physical phenomenon does the throwing of grain in the grain thrower and the stream of water in the belt water lift occur? Explain.



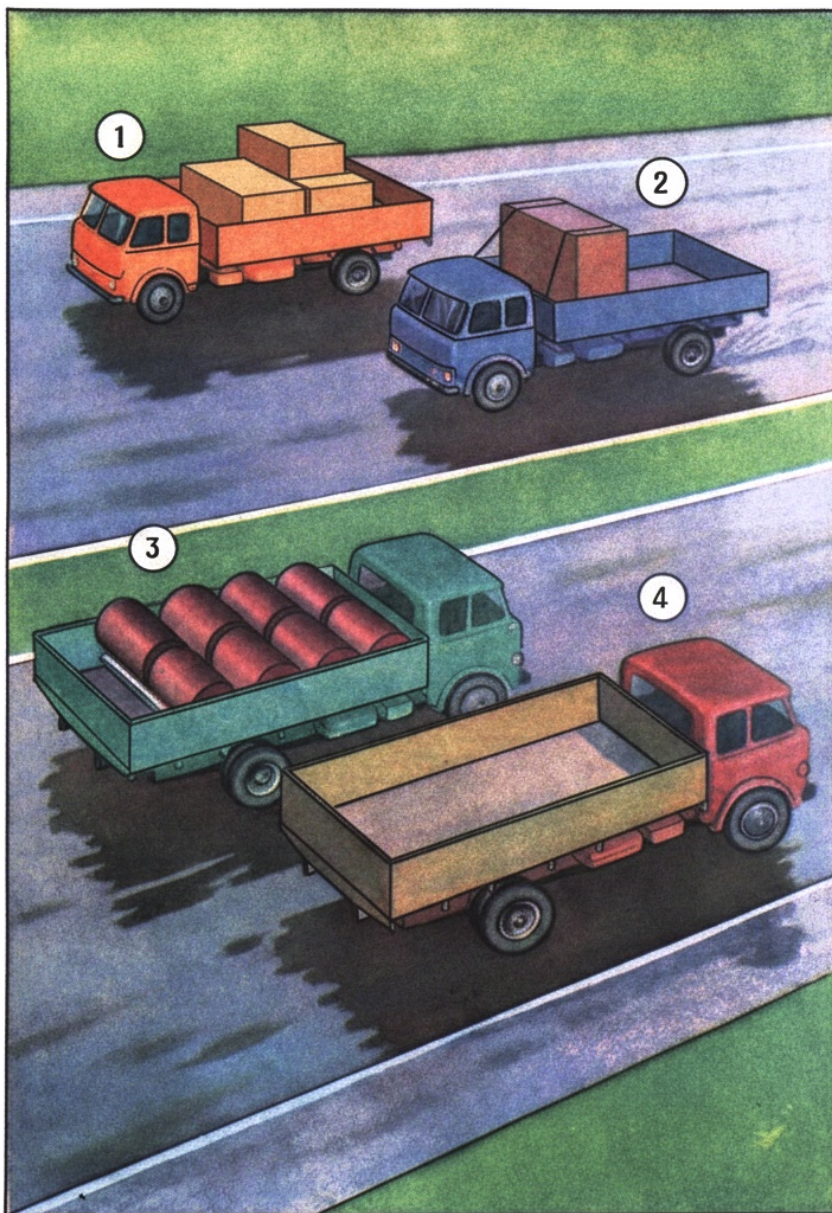
4 Which of the trolleys moving at the same speed is easier to stop?



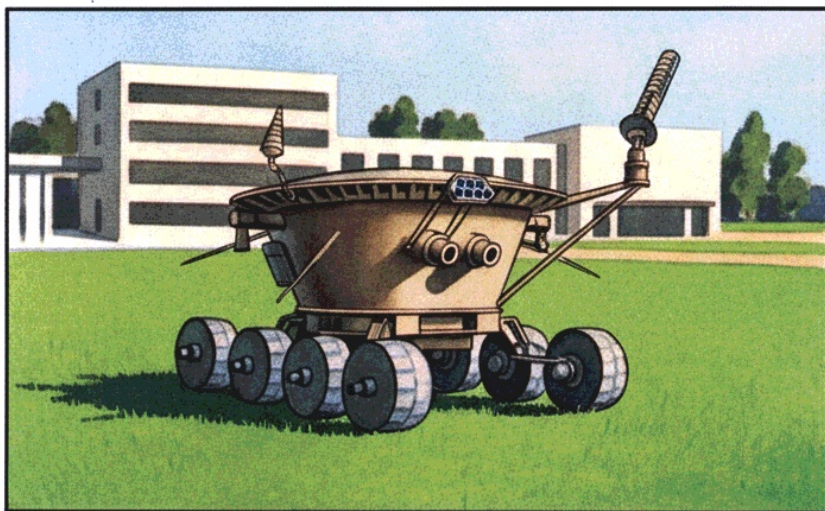
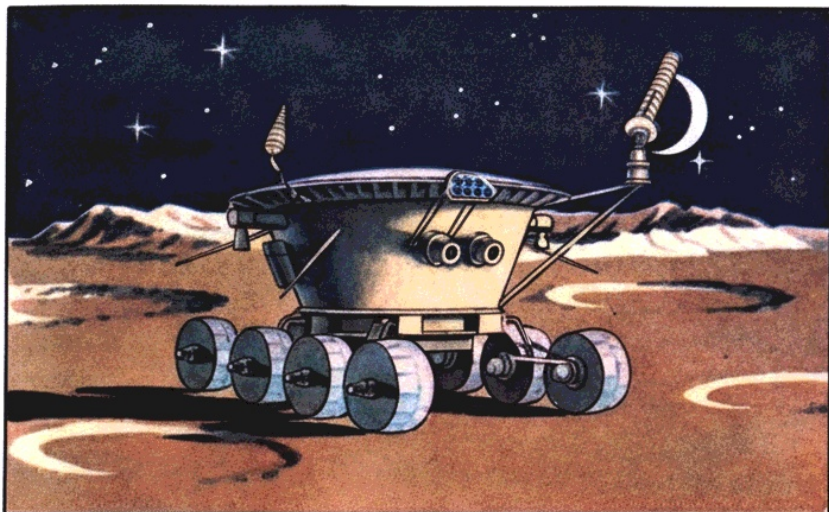
5 Which of these boats is easier to jump from to the shore and why? The boys have the same mass, and they push off the boats with equal force.



6 How do these bearings differ? Why are roller bearings used on wagons?



7 Why is it that on the same road cars 1 and 3 do not skid, while cars 2 and 4 may skid?



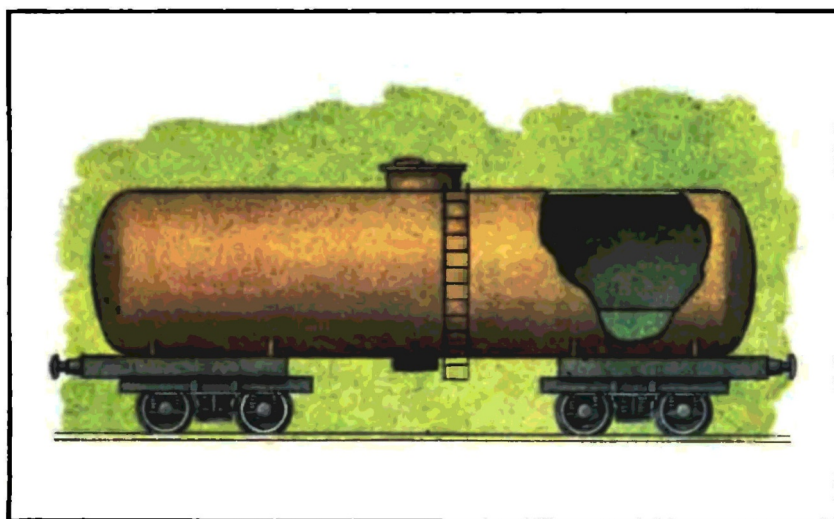
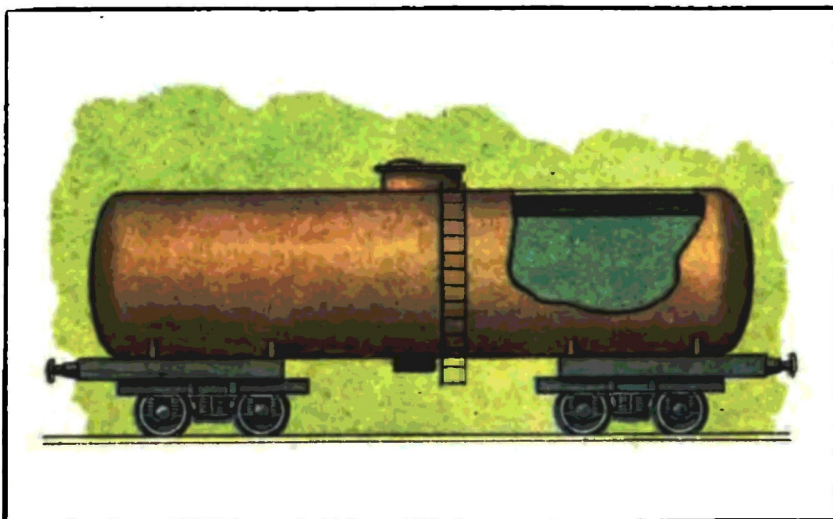
8 Is the friction on the wheel axles the same if the lunar rover moves as shown in the drawings?



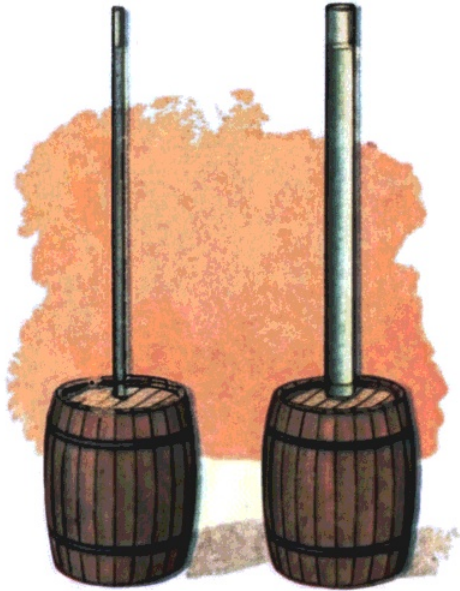
9 Which of these boys is acting correctly when helping a drowning person?



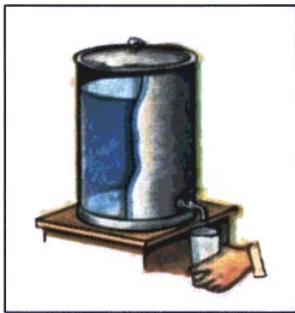
Why do these vehicles have a different number of
10 wheels?



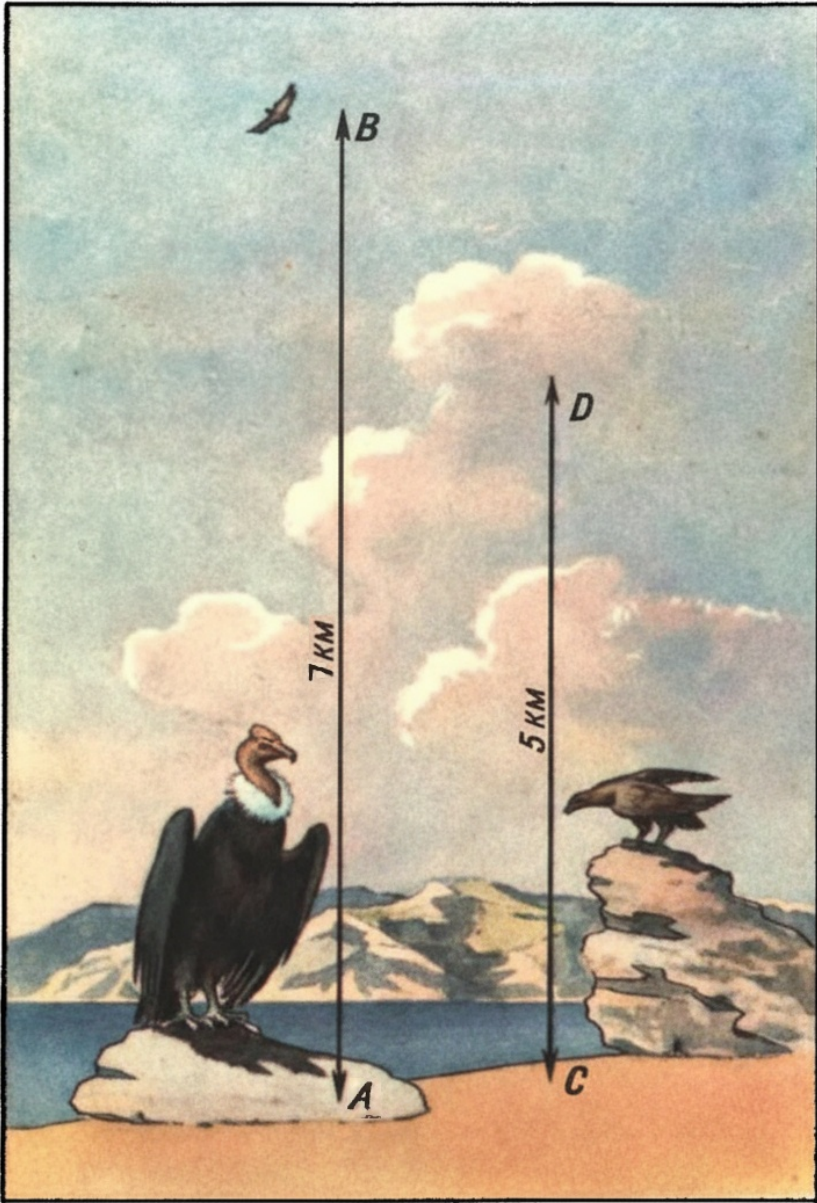
11 Is the friction force between the wheels and rails the same when two identical tank cars are moving?



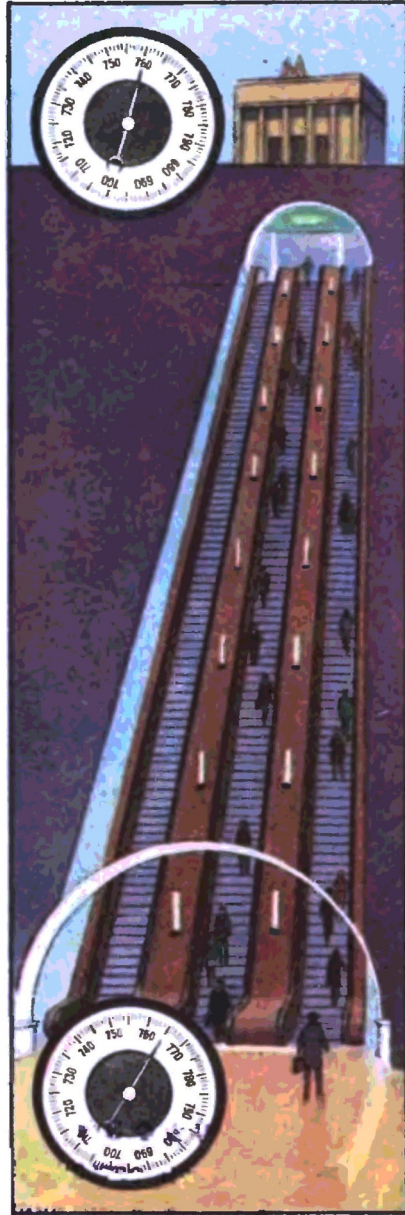
12 Is the water pressure on the bottom the same in each of these barrels?



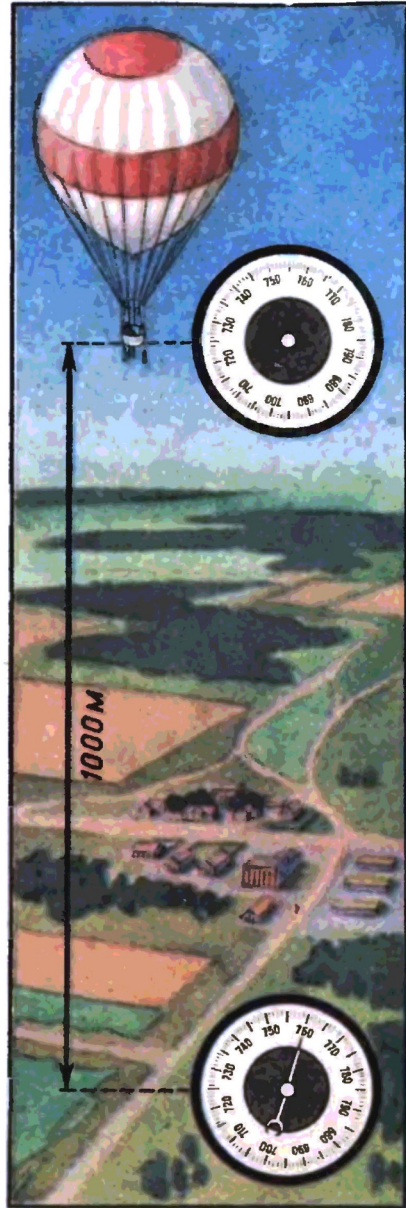
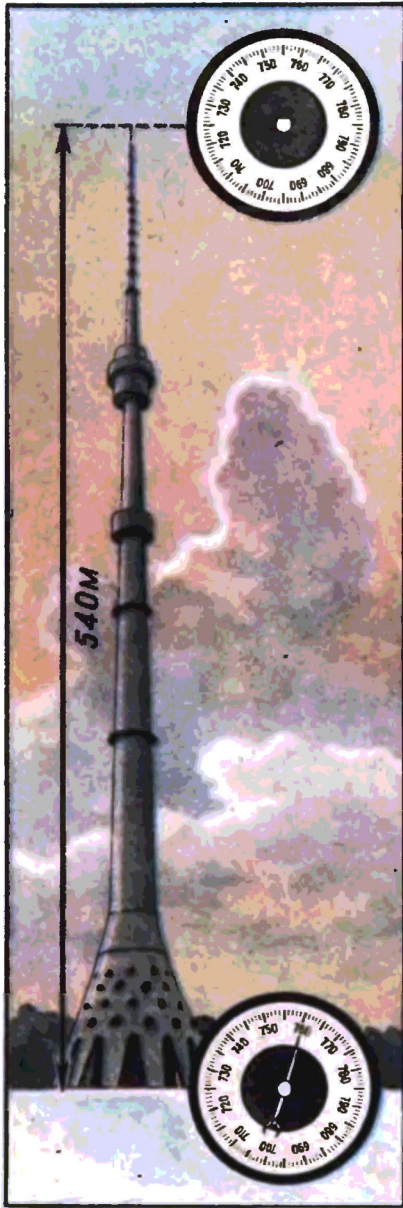
13 Which of the two glasses will fill with water faster, and why?



14 Do the same birds feel the same way at different altitudes (A and B; C and D)?



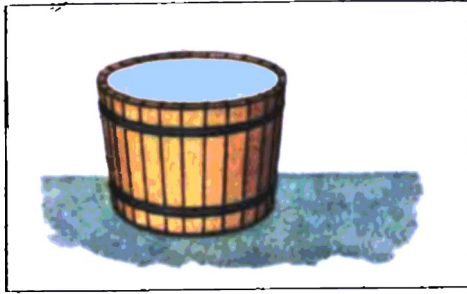
15 Can the depth of a subway mine shaft and the height of a mountain be determined from barometer readings?



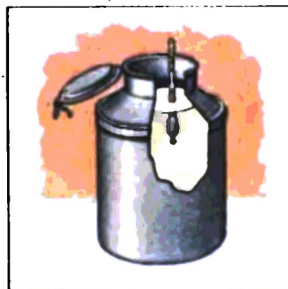
16 What will a barometer show when located on a mast and on a hot-air balloon? What will a barometer show when located on a mast and on a hot-air balloon?



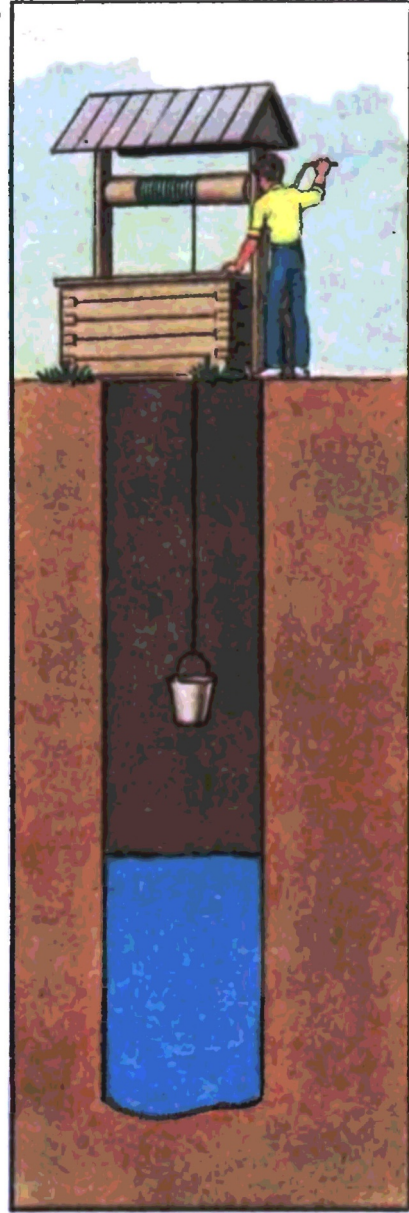
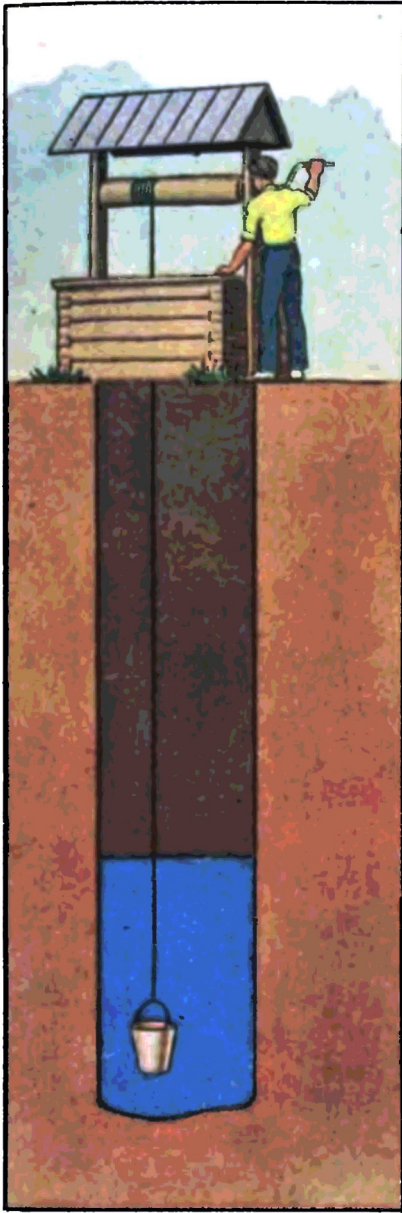
17 In which of the cases shown in the picture is it more difficult to pull identical root crops out of moist soil, and why?



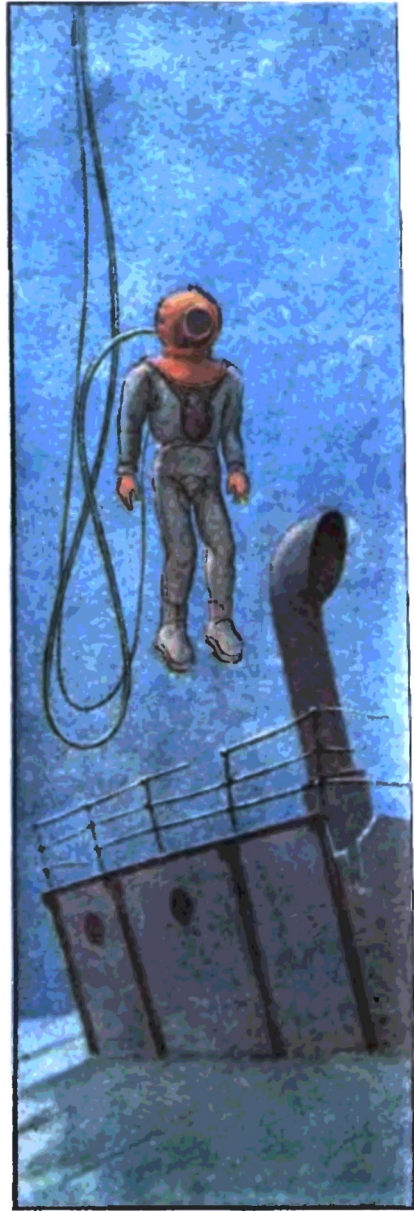
18 Two identical barrels are filled with water to the same level. Which of the barrels shown is heavier? In which barrel is the water pressure on the bottom greater?



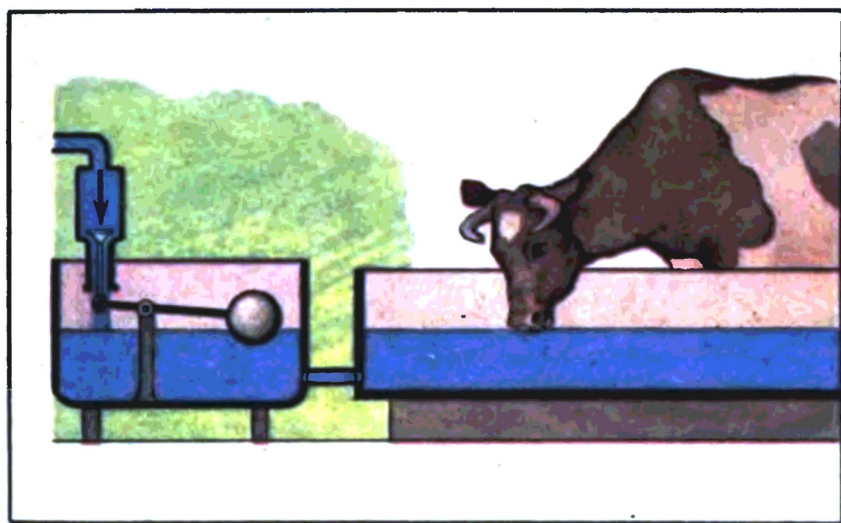
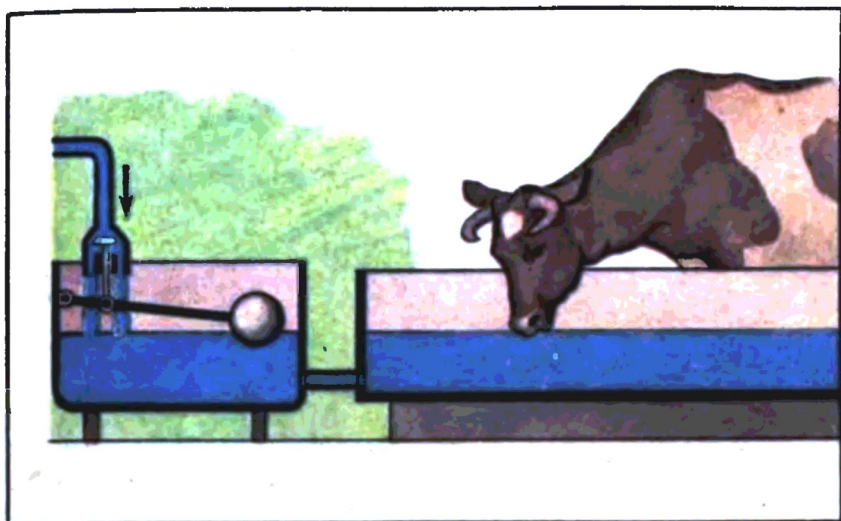
19 In which of the two milk cans does the milk have a higher fat percentage?



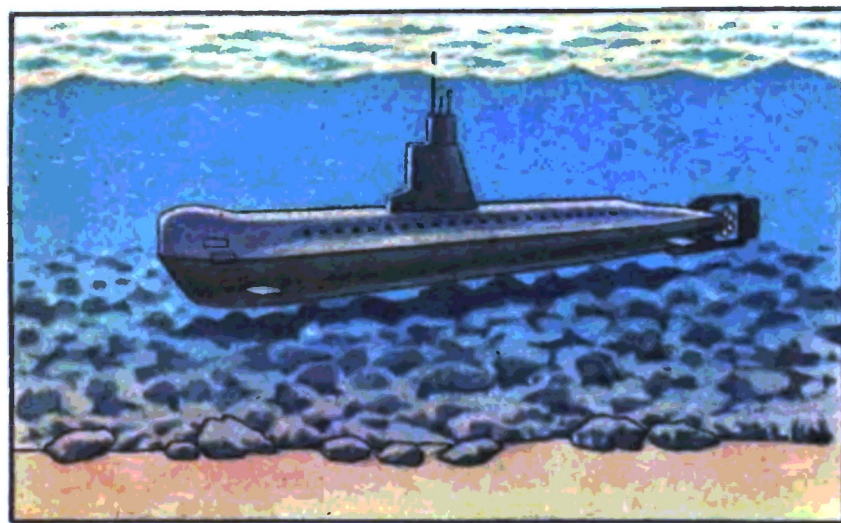
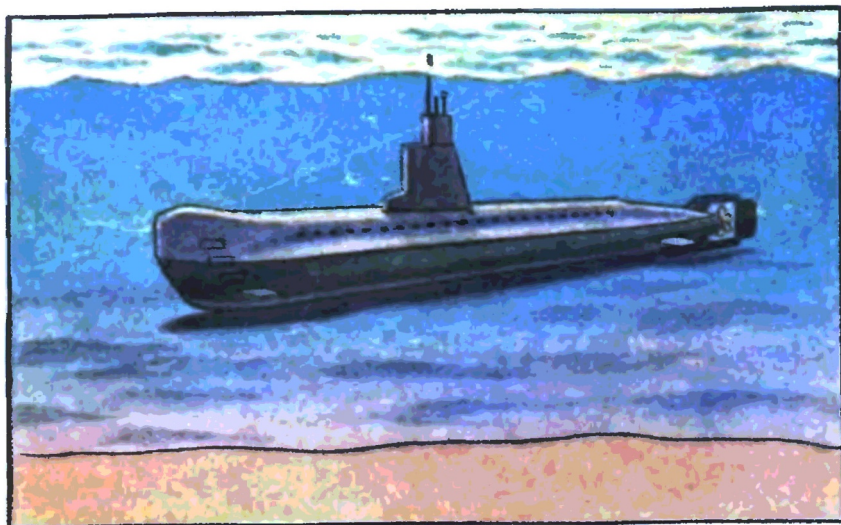
At what moment is it easier to lift a bucket from a well?



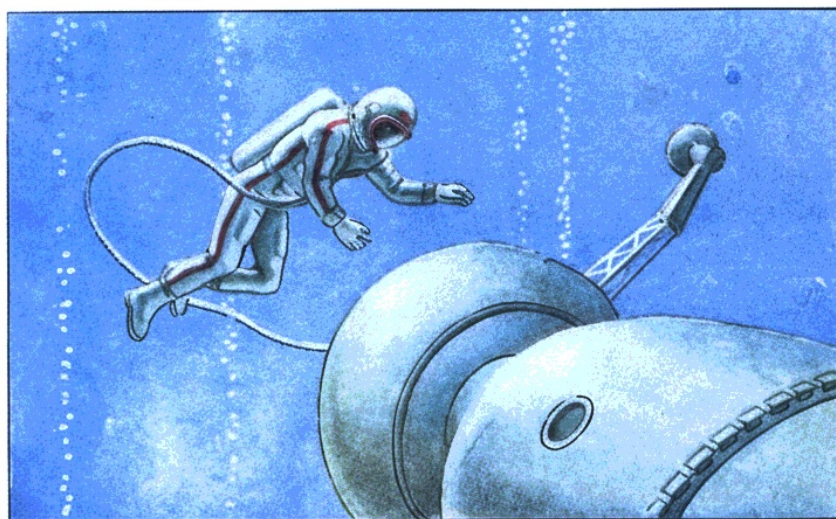
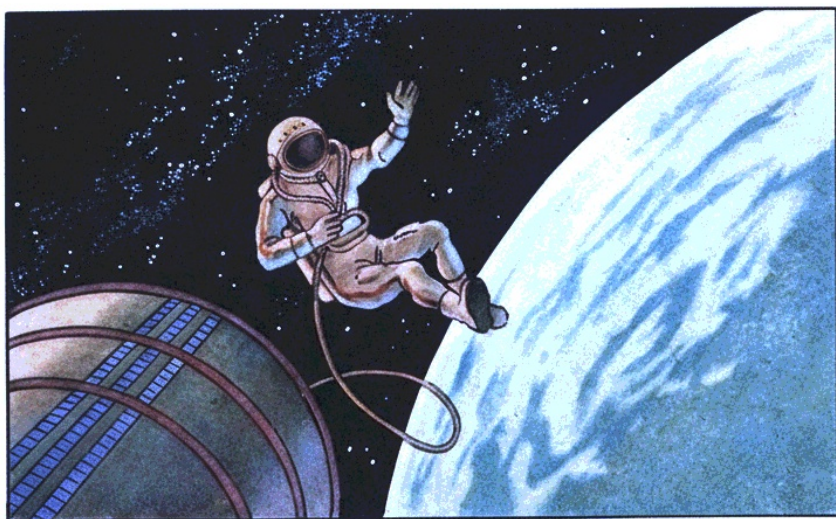
21 How can a diver wearing a soft diving suit manage to surface?



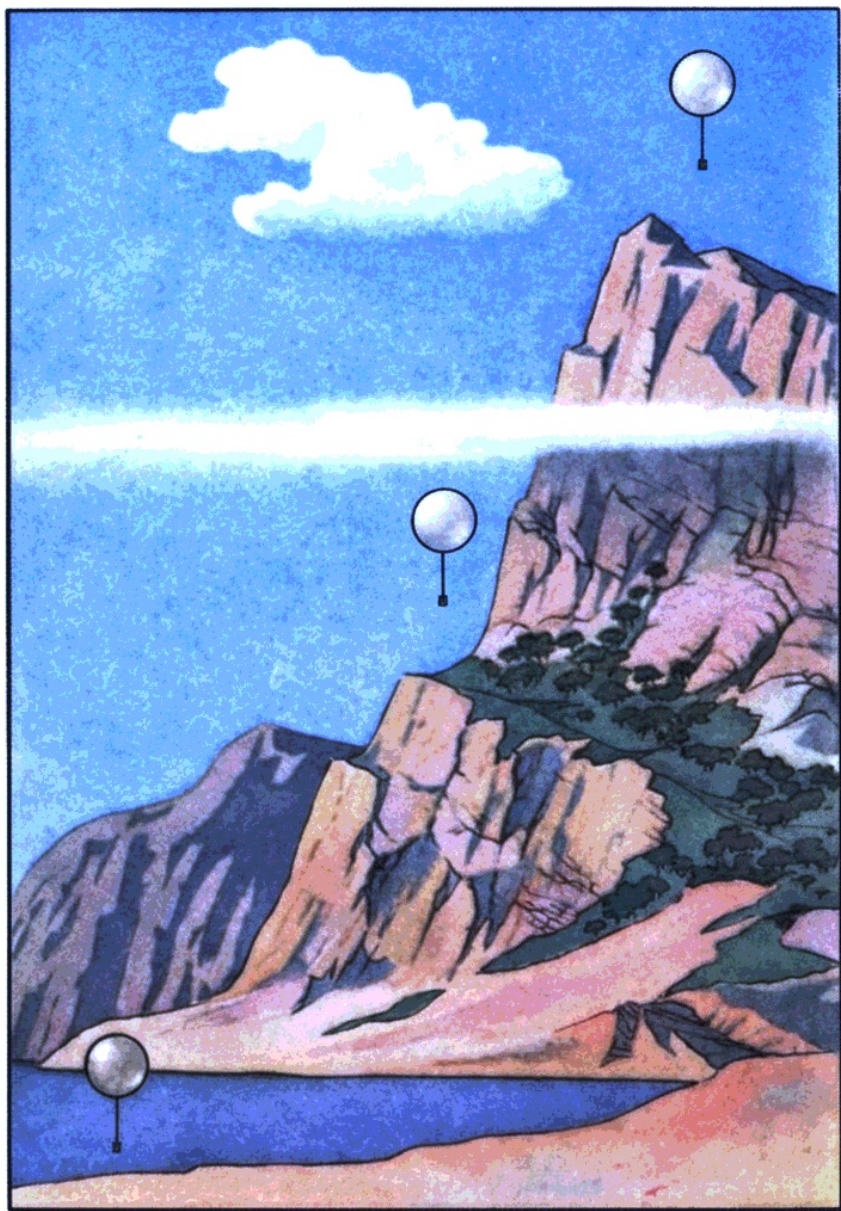
22 Explain how uninterrupted water supply is ensured in these float-type automatic drinkers.



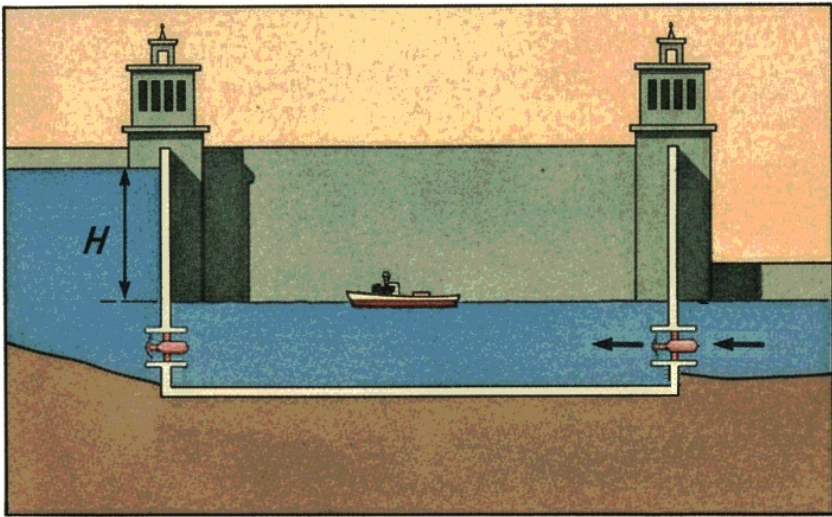
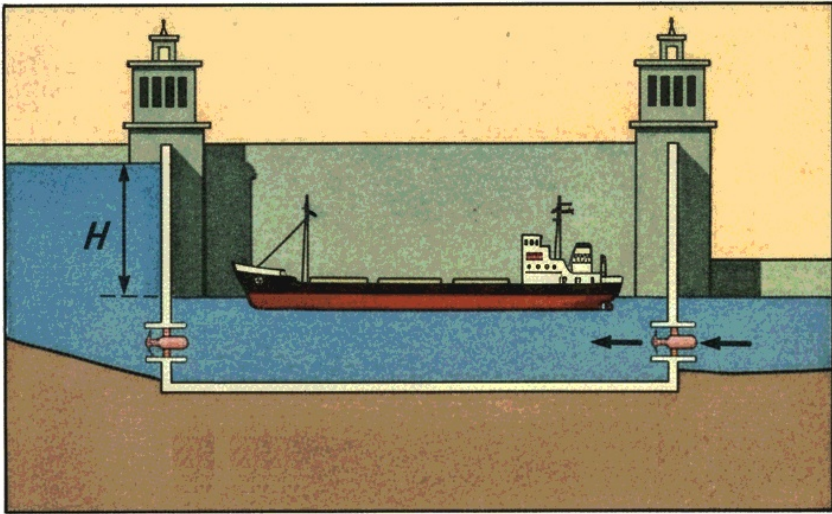
23 On which type of sea bottom (rocky or clayey) can a submarine be lowered, and why?



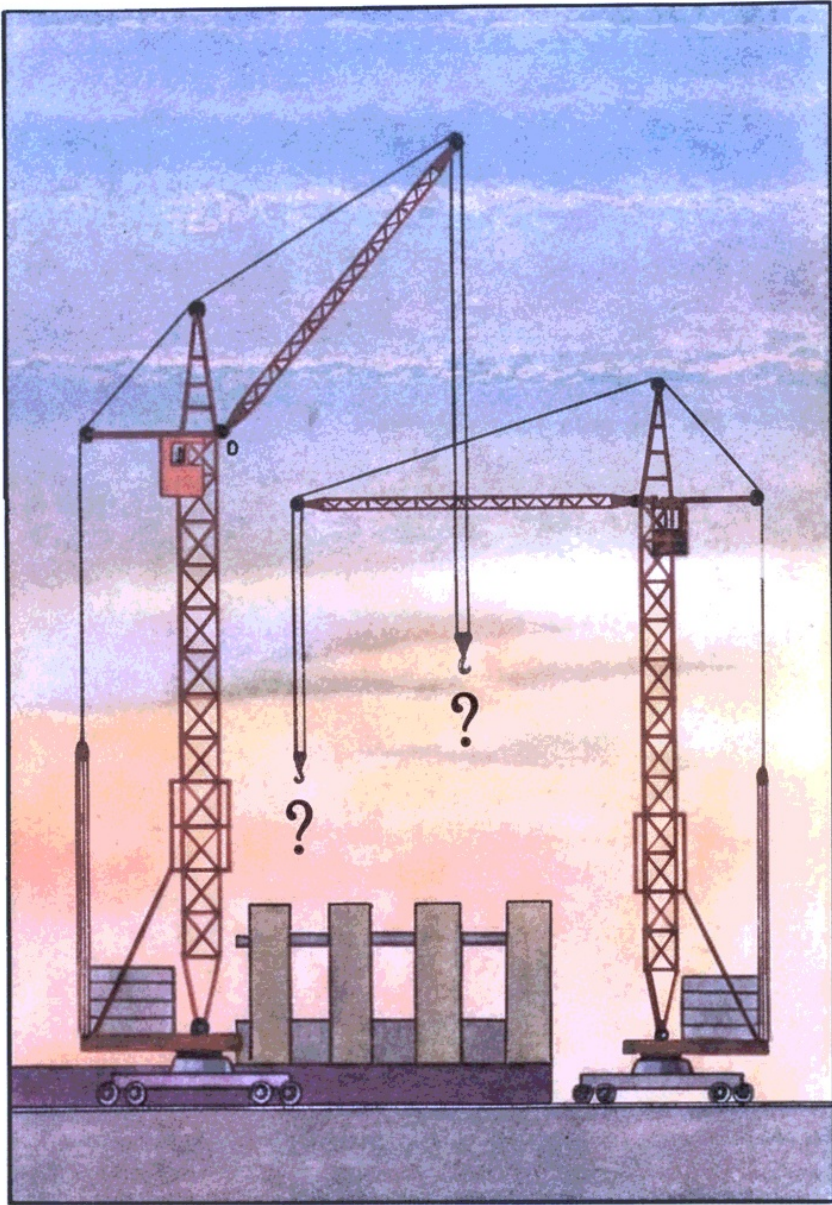
24 How do the physical conditions of the cosmonauts differ in the cases shown in the pictures?



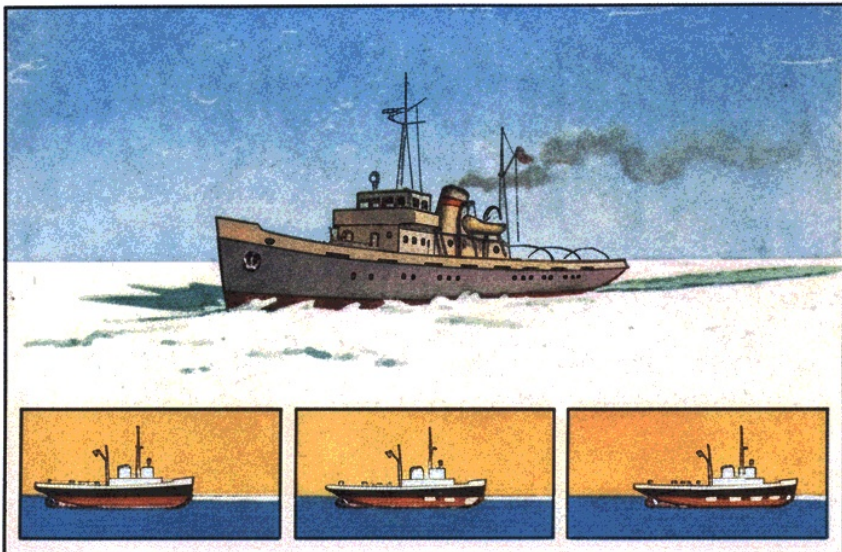
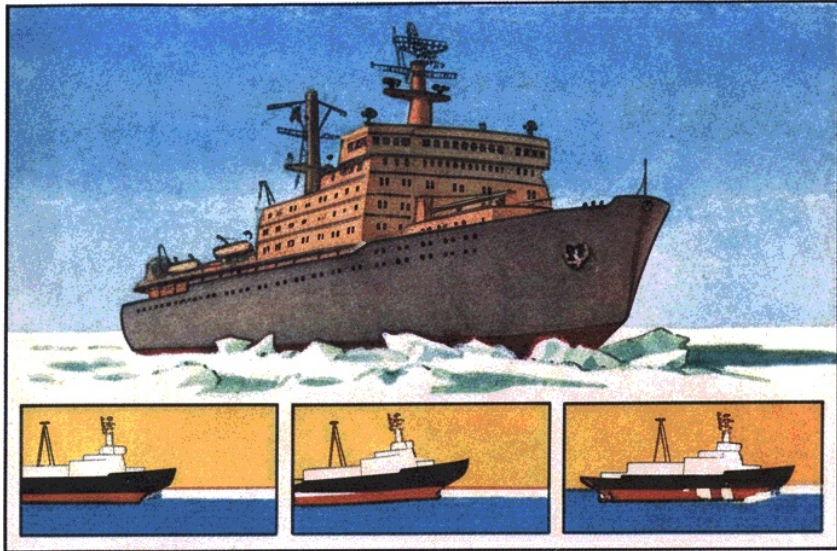
25 What mistake did the artist make in depicting the same weather balloon at different altitudes?



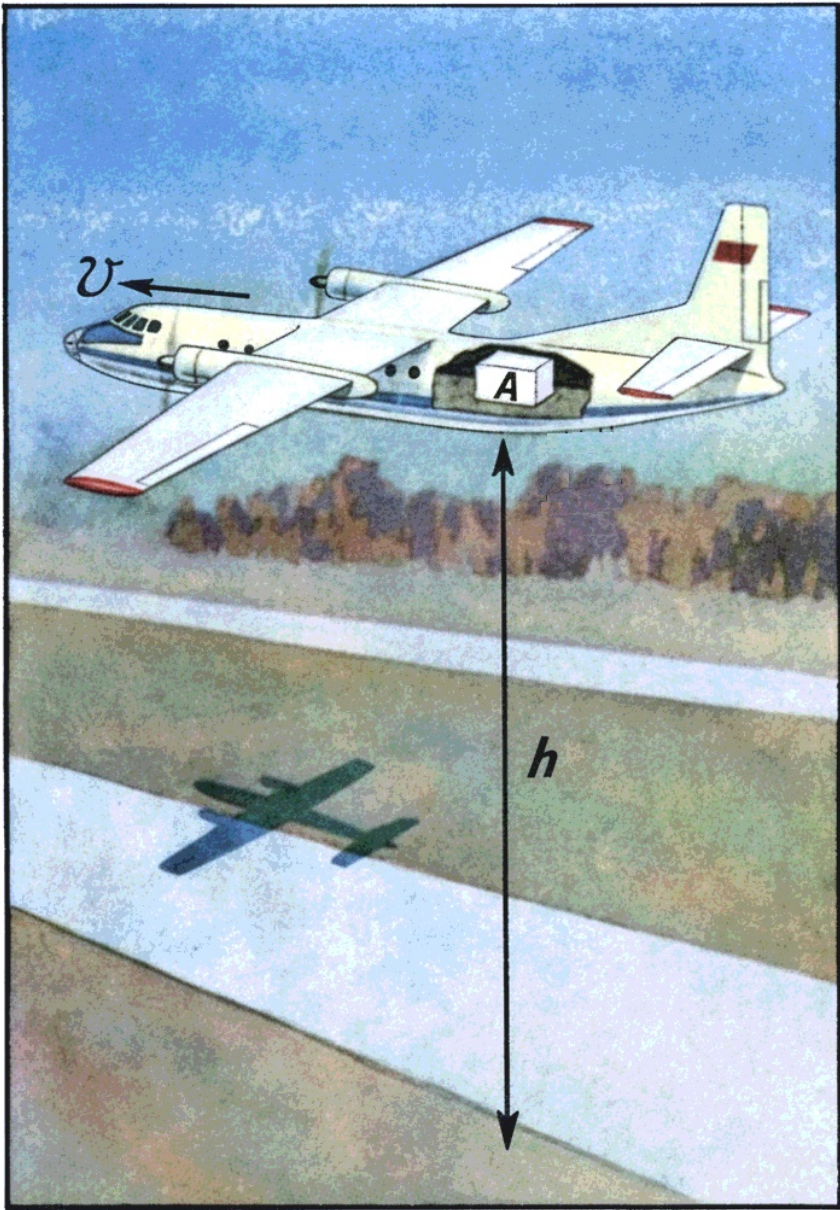
26 In which case will the sluice pumps perform more work when raising the water to height H ?



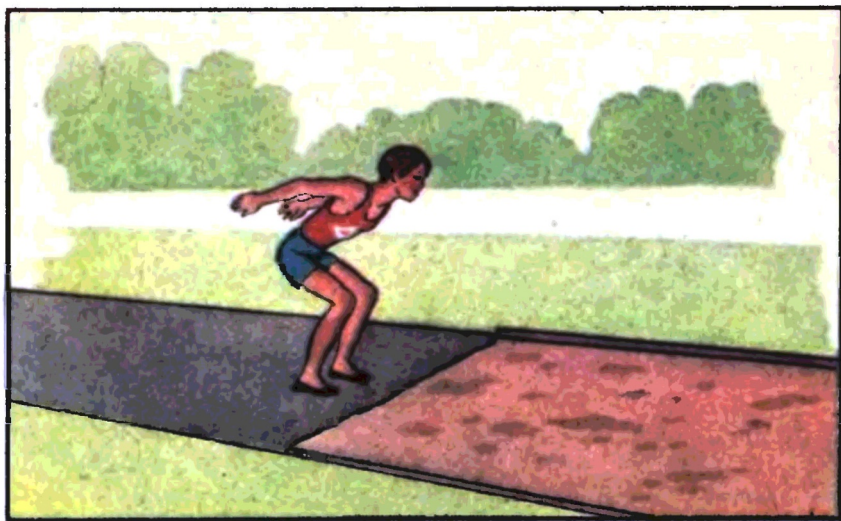
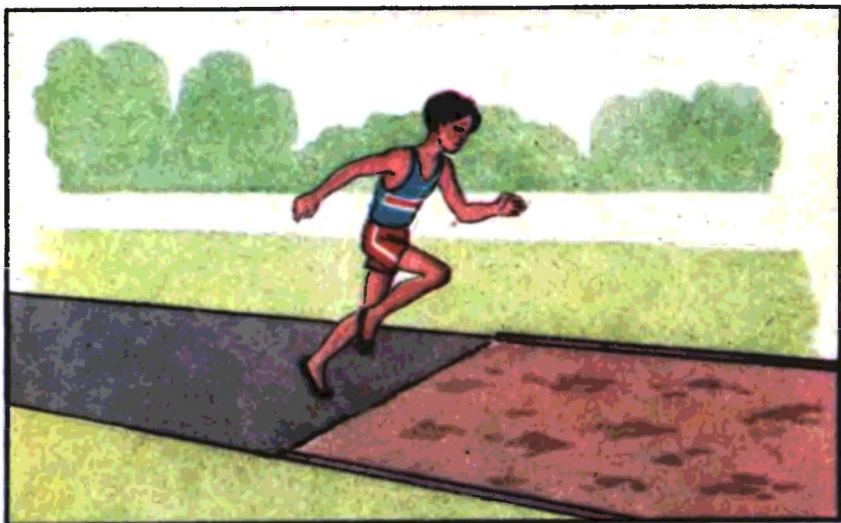
27 In which position of the boom can a tower crane lift more load, and why?



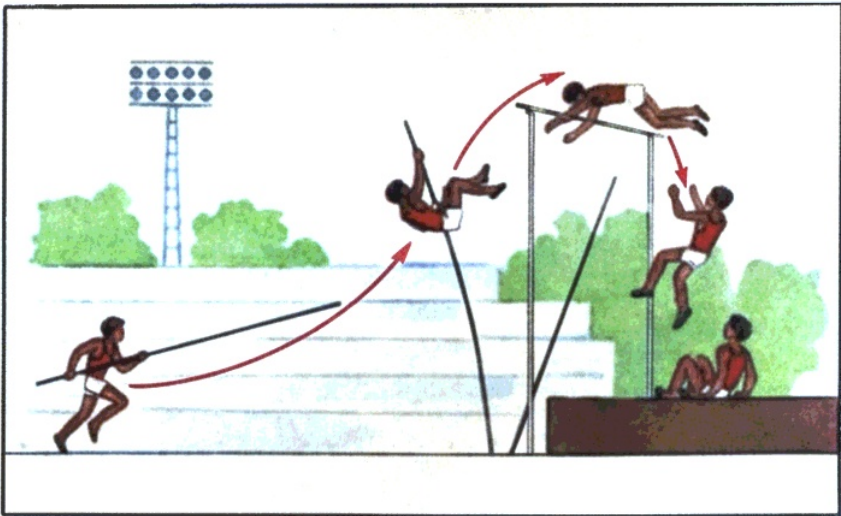
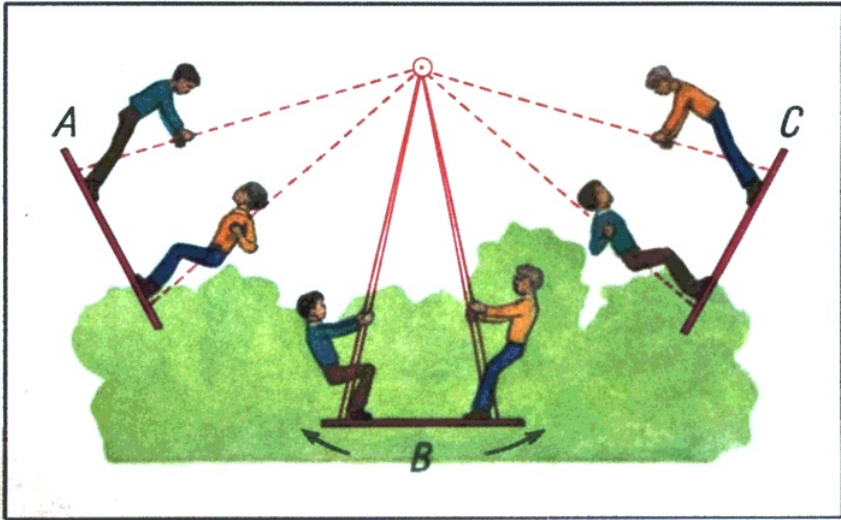
Due to what type of mechanical energy is the ice
28 destroyed in these cases? Explain.



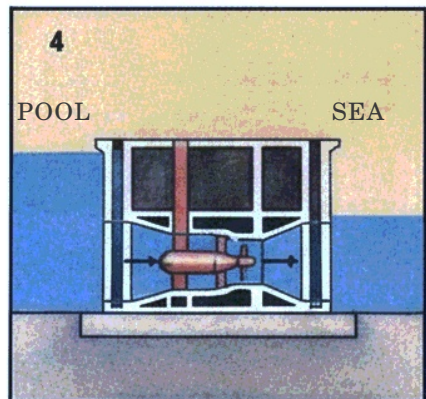
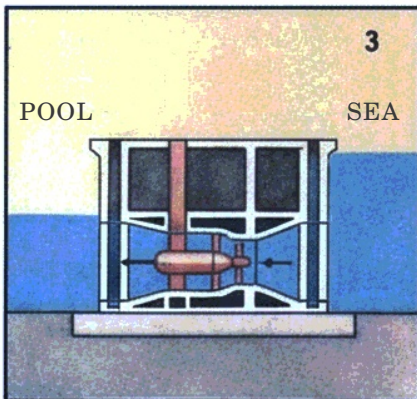
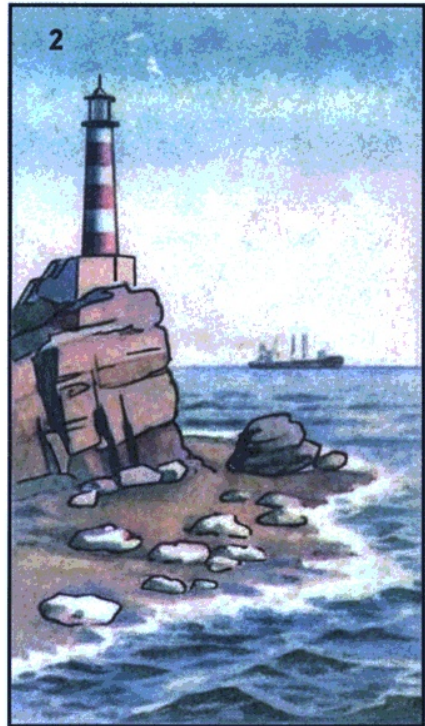
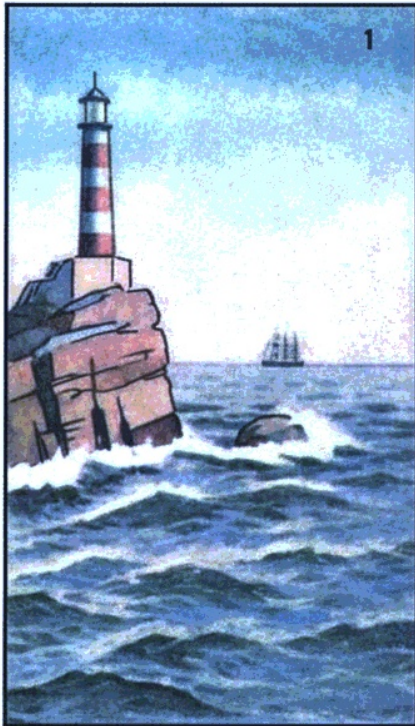
29 What energy does load A have relative to the airplane floor and relative to the surface of the Earth?



30 In which of the depicted cases will the same boy jump farther?

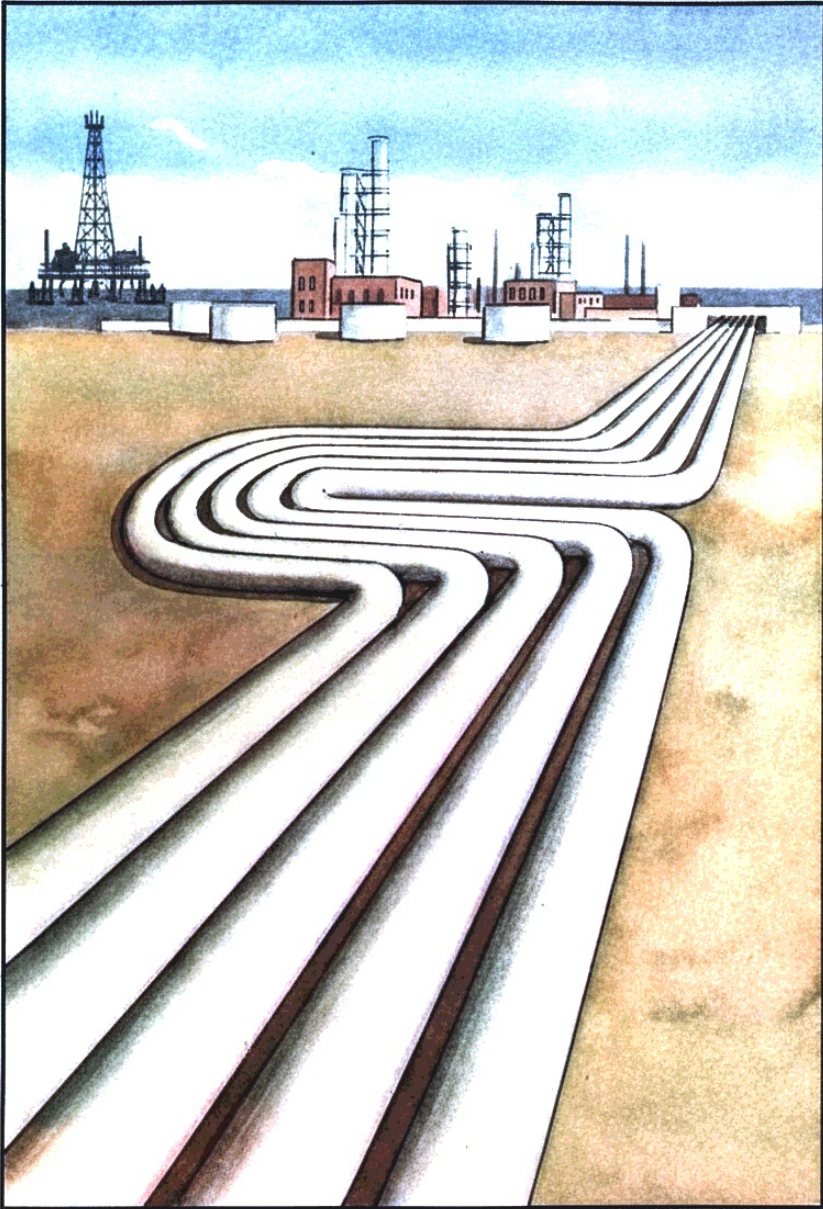


31 What transformations of mechanical energy occur during the motion of the swings and the athlete?

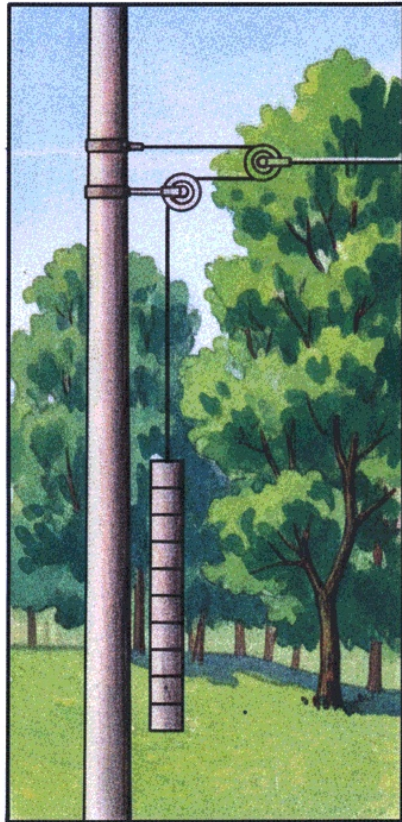
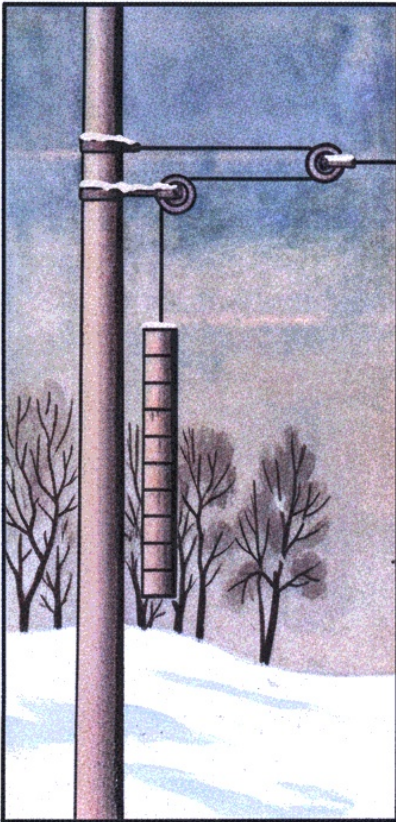
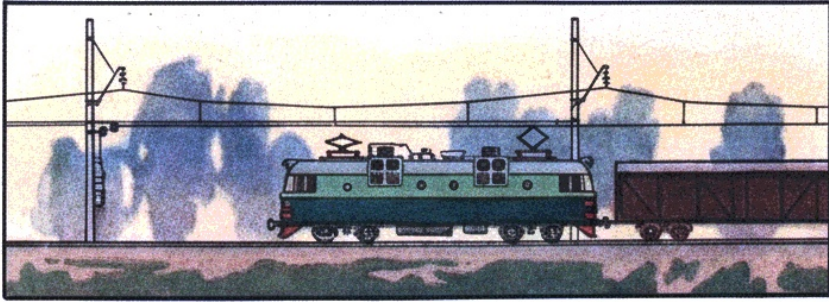


32

1. The hydroelectric power station shown in Figures 3 and 4 is located on the seashore. Explain how it works. Pay attention to the natural phenomena illustrated in Figures 1 and 2.
2. What energy transformations occur when water is moved in Figure 3?



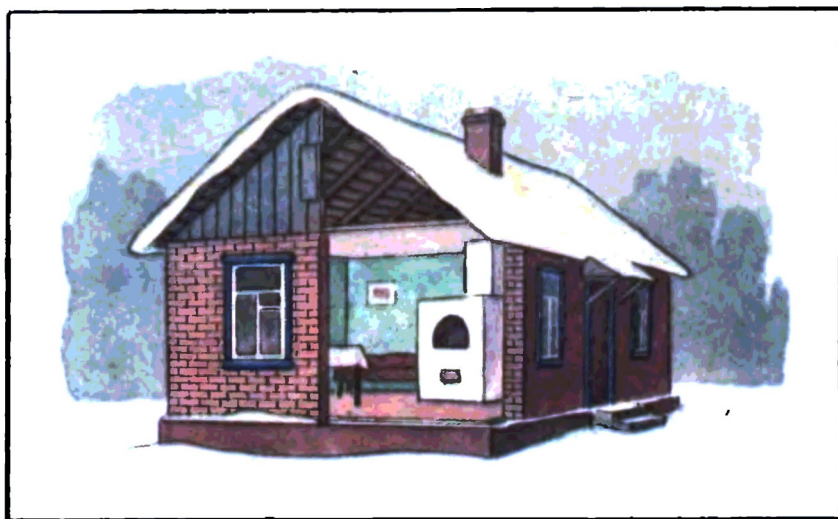
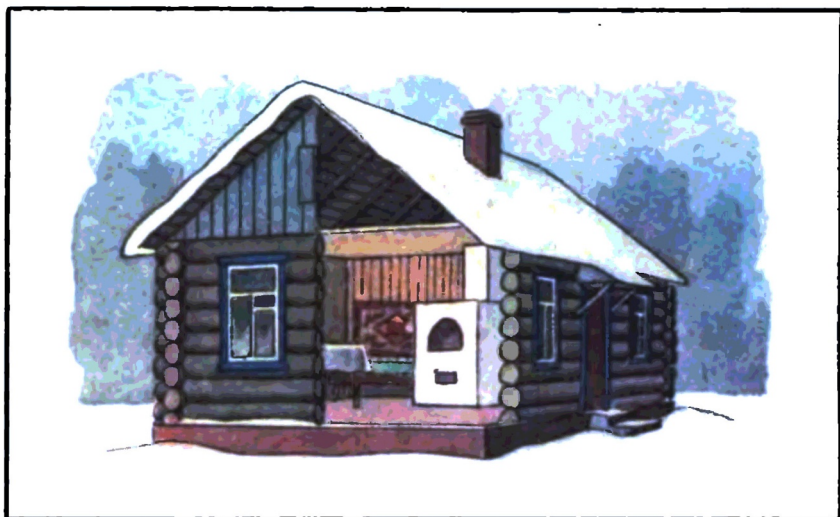
33 Why are loops made in some places when laying a system of pipes (oil pipelines, gas pipelines, steam pipelines)?



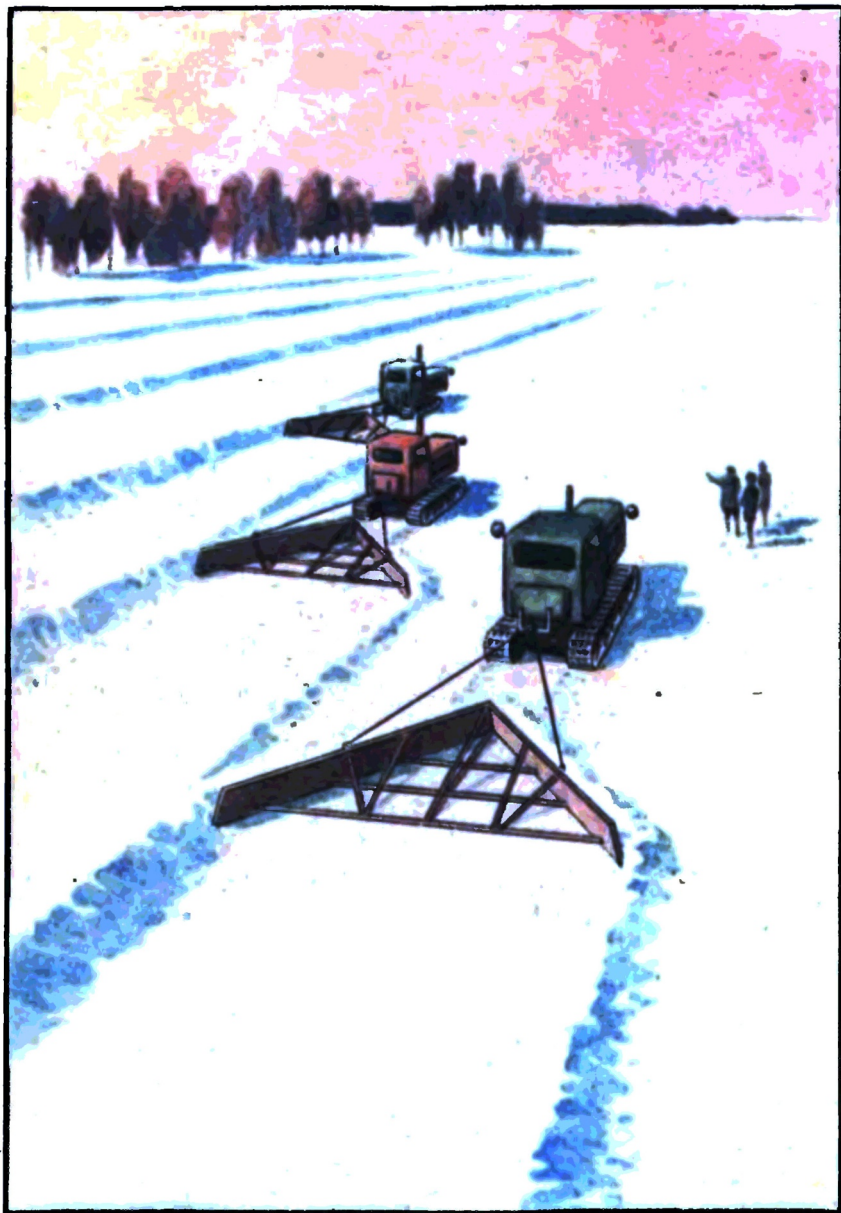
Determine from these drawings what caused the
34 change in the length of the current-carrying wires.



Which pair of geese is warmer and why?



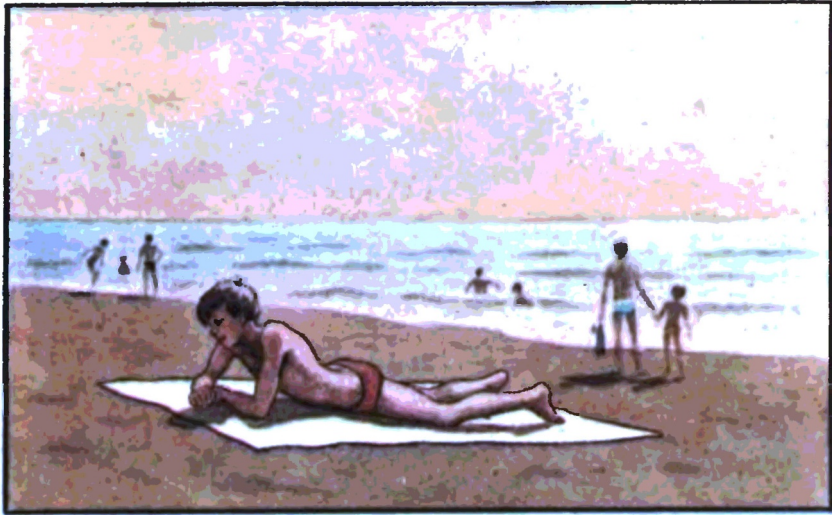
Which house is warmer in winter if the wall thickness
36 is the same?



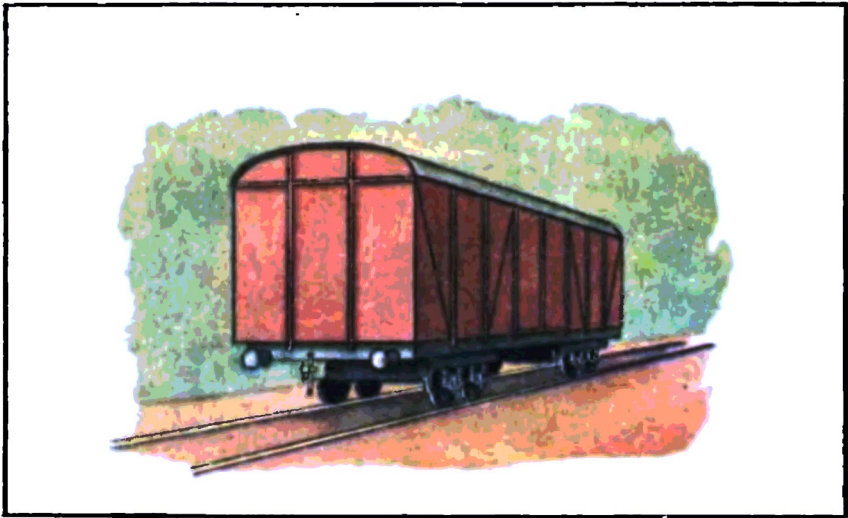
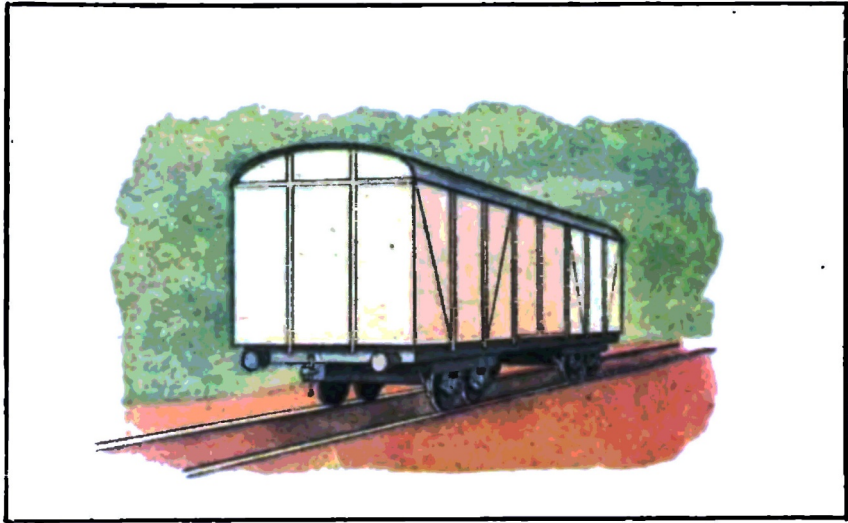
What physical phenomenon is used in snow retention?



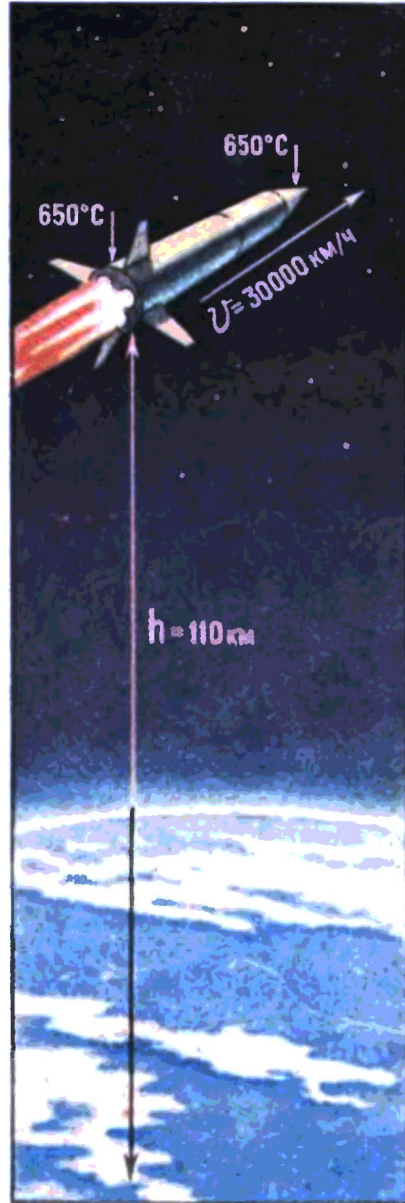
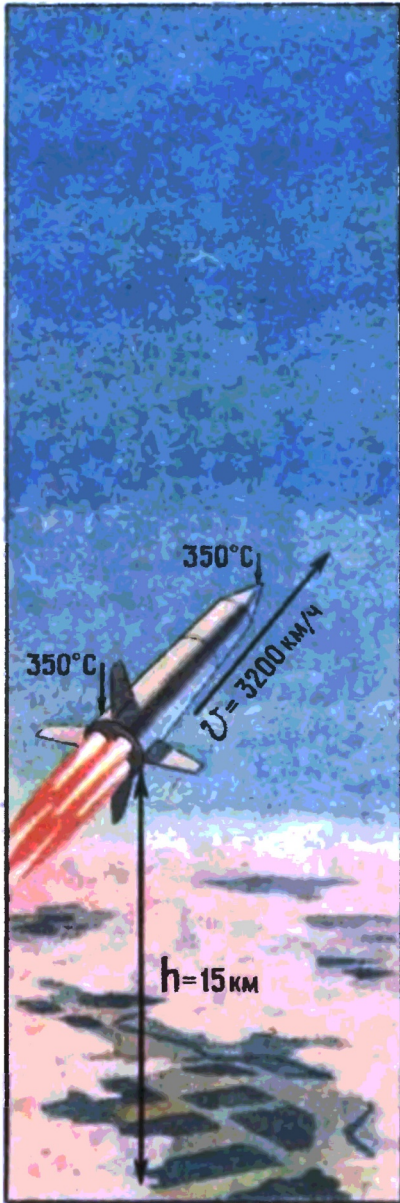
38 Why does the smoke from a campfire at the forest edge have different directions in calm weather in the drawings?



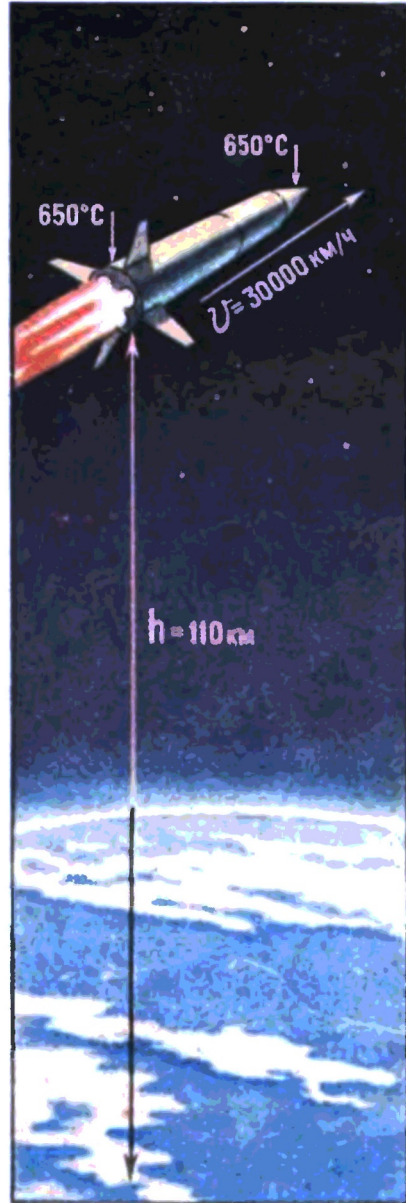
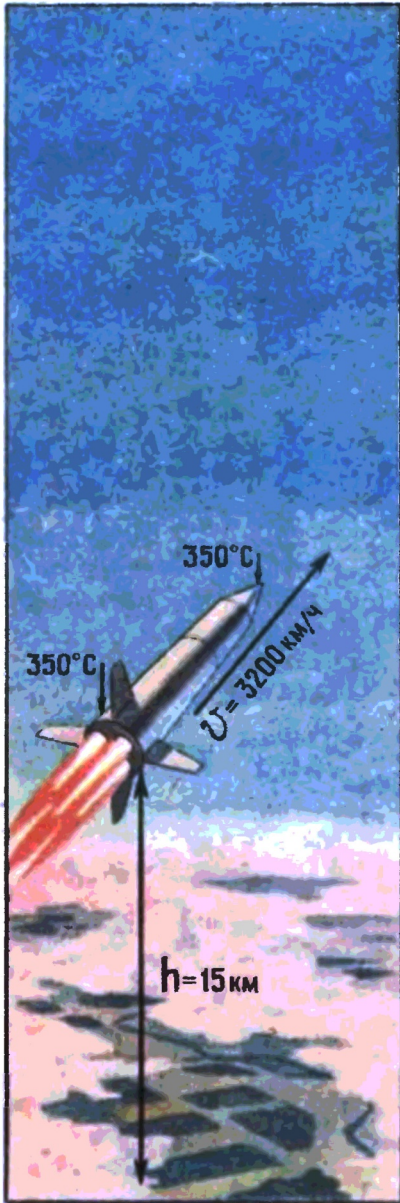
39 By what means is energy transferred from the heat source to the boys?



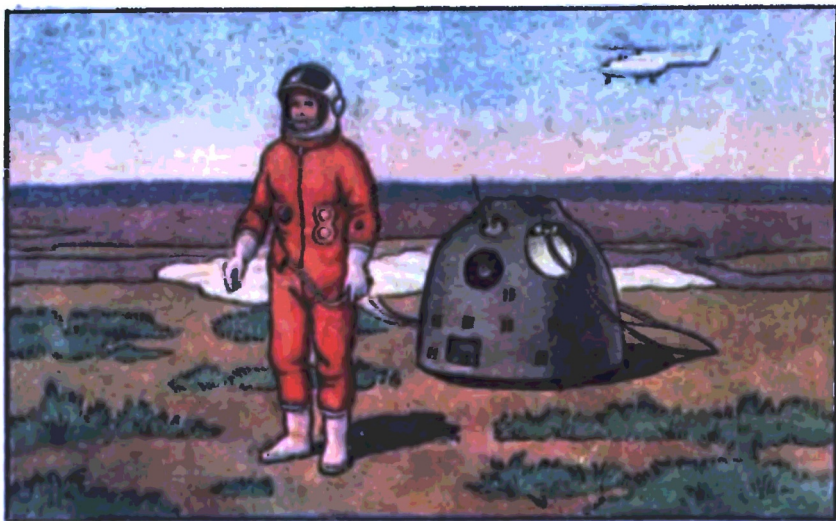
40 In which of these railcars are perishable goods transported? Why?



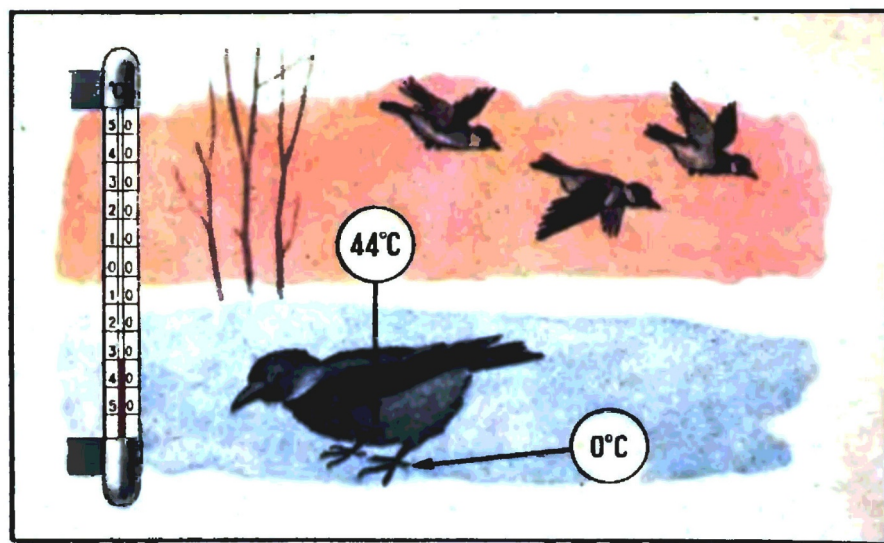
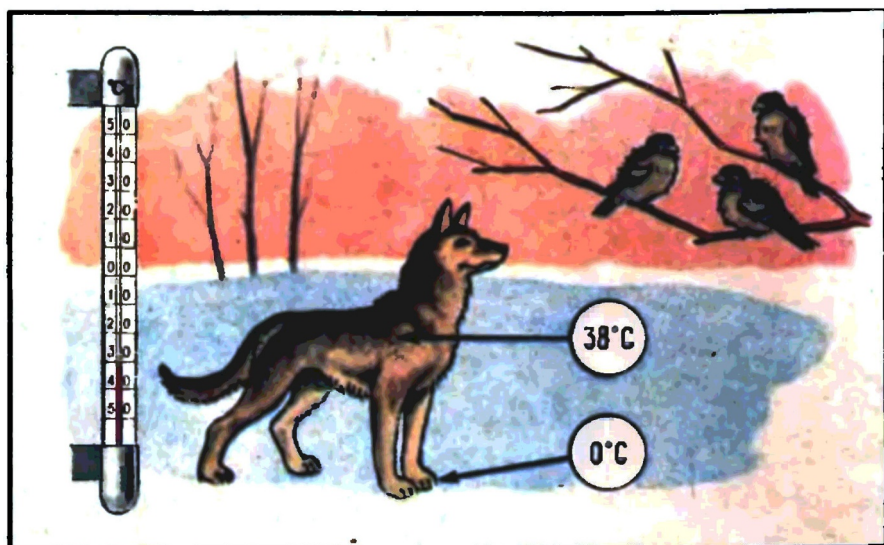
41 Are the rockets shown in the picture, which occupy the same position relative to the Sun, heated in the same way?



41 Are the rockets shown in the picture, which occupy the same position relative to the Sun, heated in the same way?

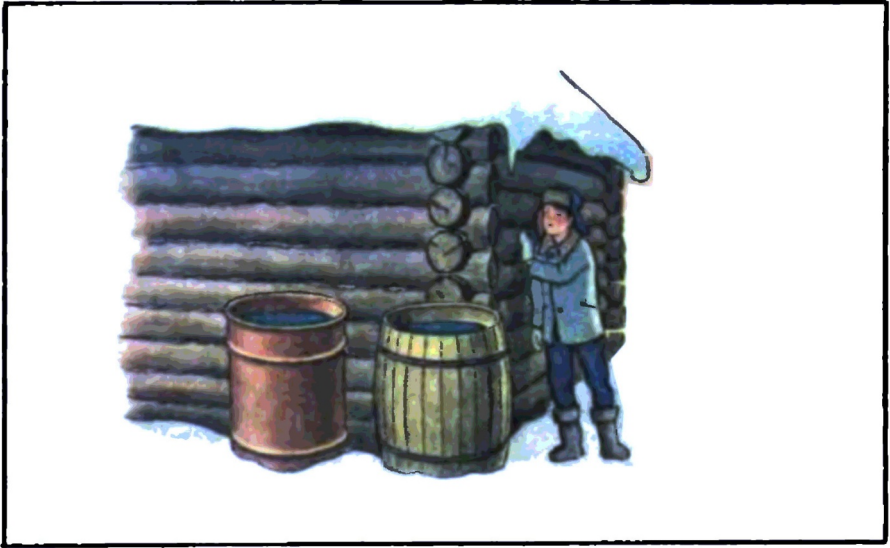


42 Why do the spacesuits of the cosmonauts shown in the picture have different colors?



Do the bodies of the birds shown in the picture cool equally at the indicated temperature?

What is the significance for the life of animals and birds of the different temperatures of parts of their bodies?



Explain why these boys hear the cracking of the tree trunk and the barn logs.

44 In which of the two barrels will the water freeze faster if the capacity of the barrels is the same?



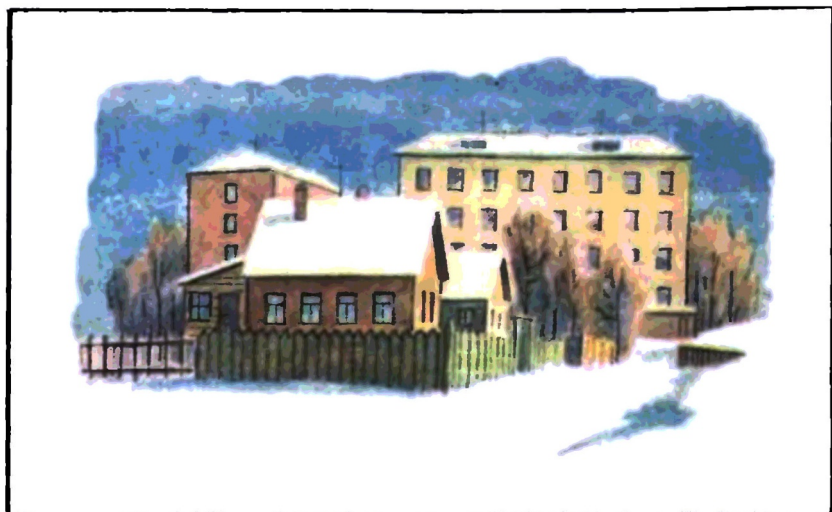
Where will the snow melt faster and why?

45 Where in the pictures shown will the soil freeze deeper and why?

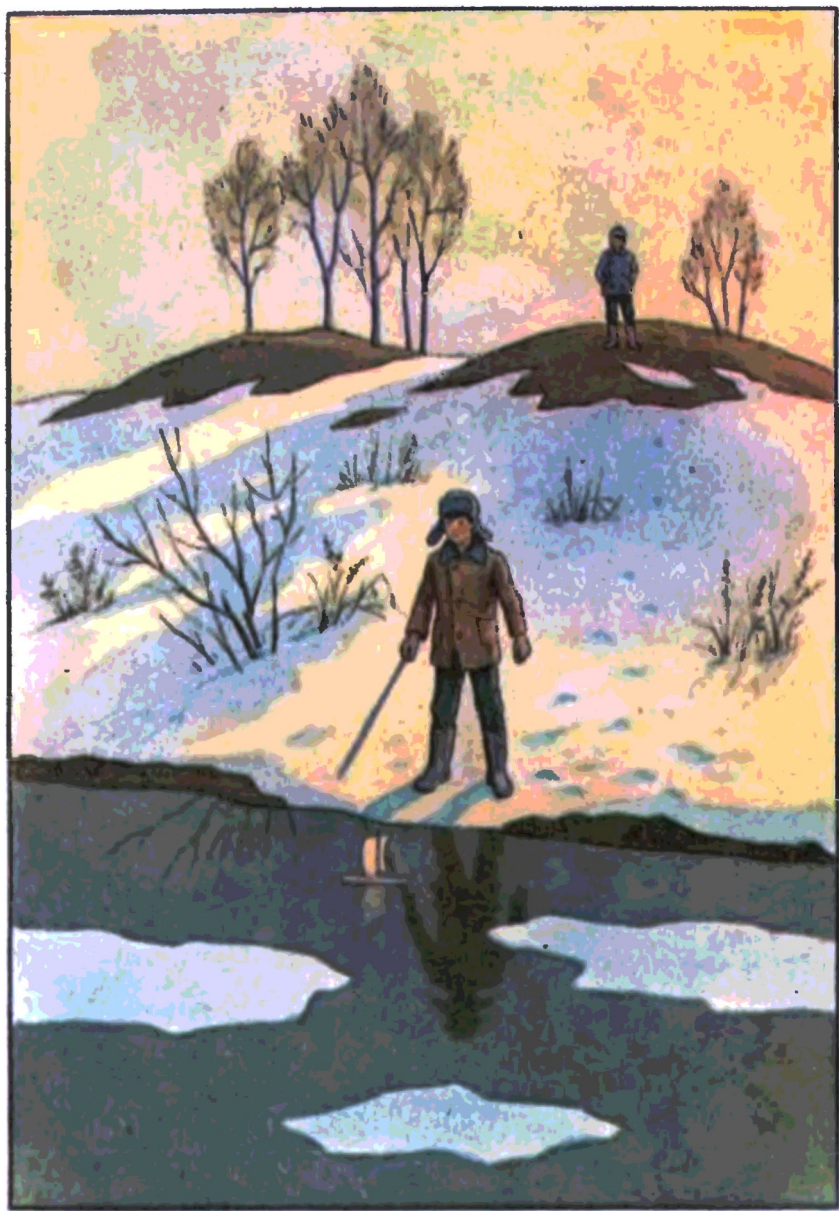


Which of these ice crossings is more reliable and why?

46 When will the flood be greater: in a snowy or snowless winter and why?



47 Will the air temperature change if the weather condition in the upper picture becomes like in the lower picture?



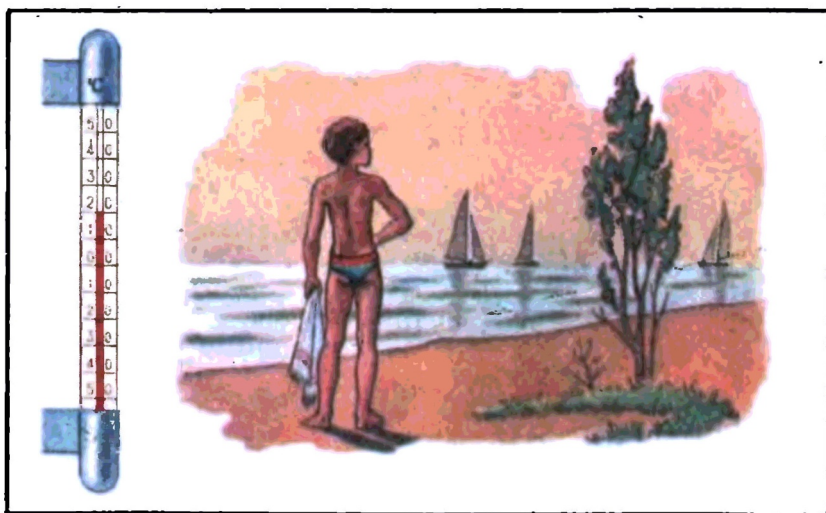
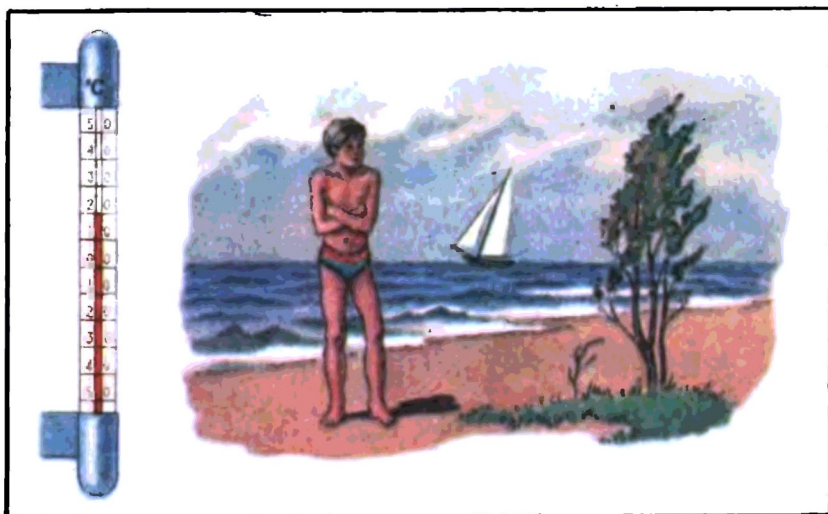
Which of the two observers is colder during the ice
48 drift and why?



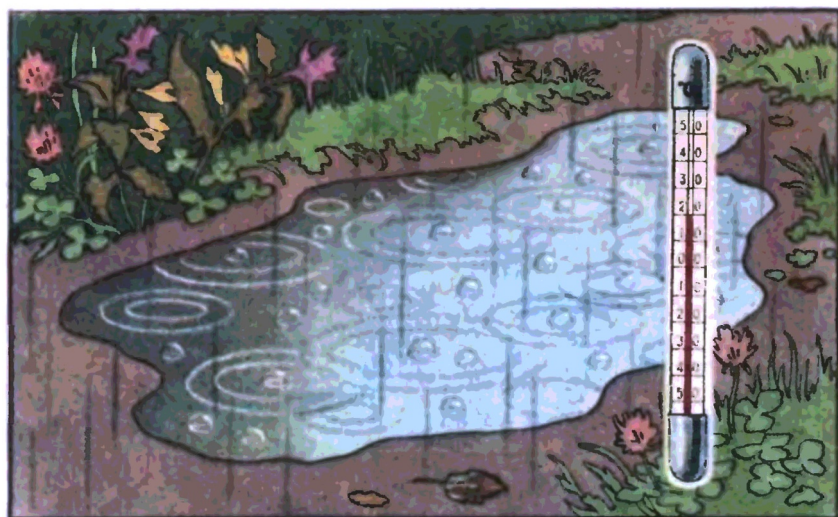
49 Before winter cold, it is recommended to water the soil in the garden. In which garden will the soil freeze deeper in winter and why?



50 In which forest will the path remain wet longer after rain and why? (The soil composition and age of trees are approximately the same.)

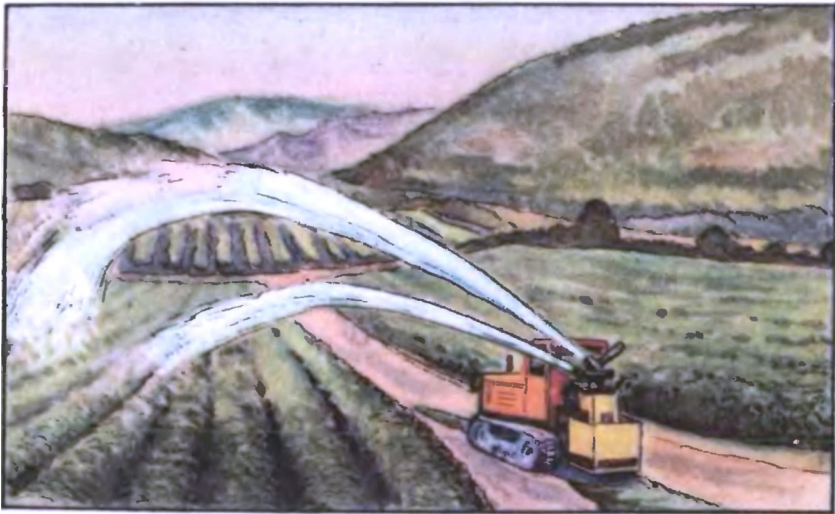


Which of the boys is colder after bathing and why?



There are no bubbles on puddles during rain.

52 Bubbles form on puddles during rain. Why?



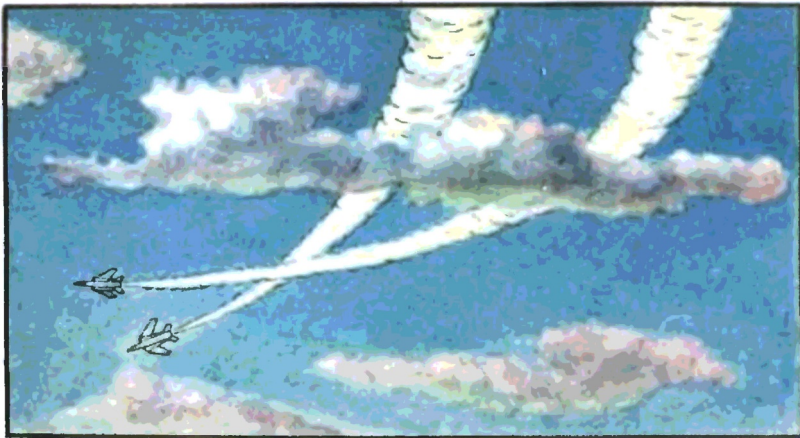
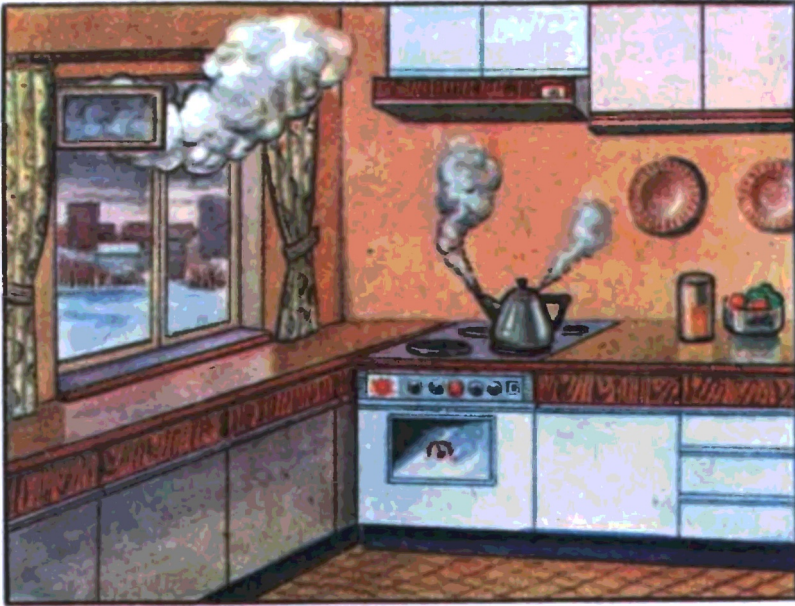
53 Why did the plants freeze during the morning frost in the upper picture, but not in the lower one?



Why are the readings of thermometers placed in boiling water different in the cases shown?

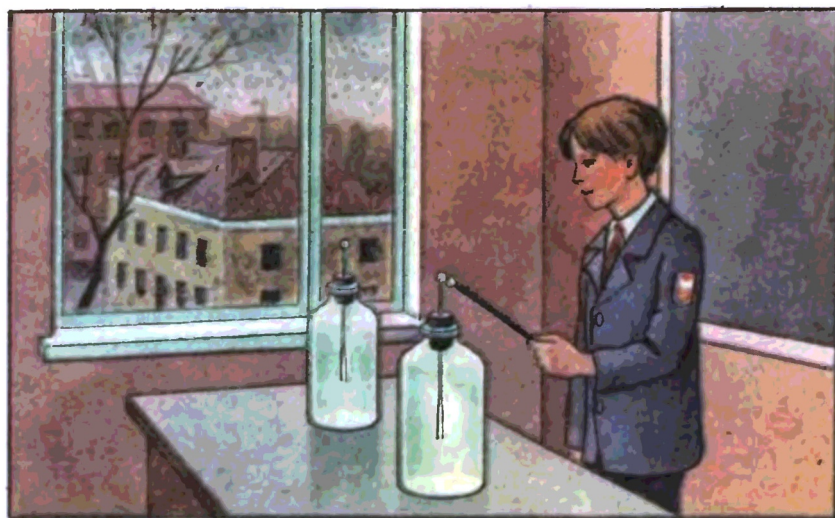
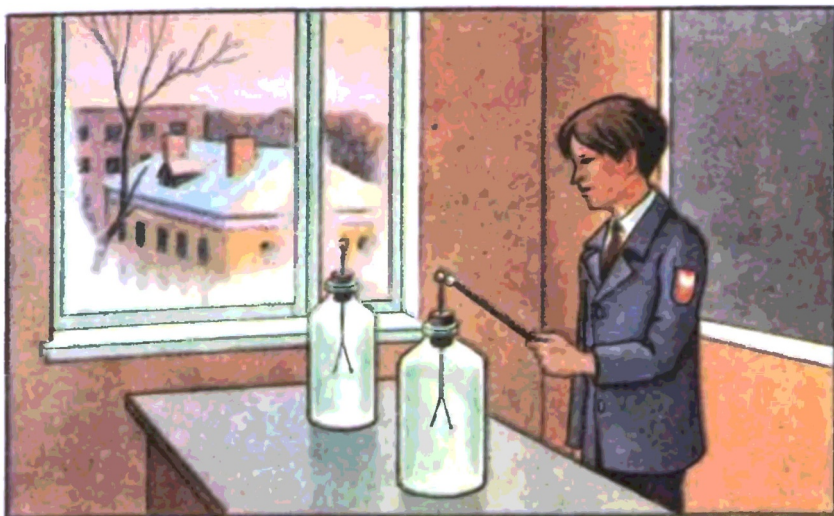
Is it possible to determine the height of a mountain and the depth of a gorge from the readings of these thermometers?

54



Is there a similarity in the physical phenomena depicted in these drawings?

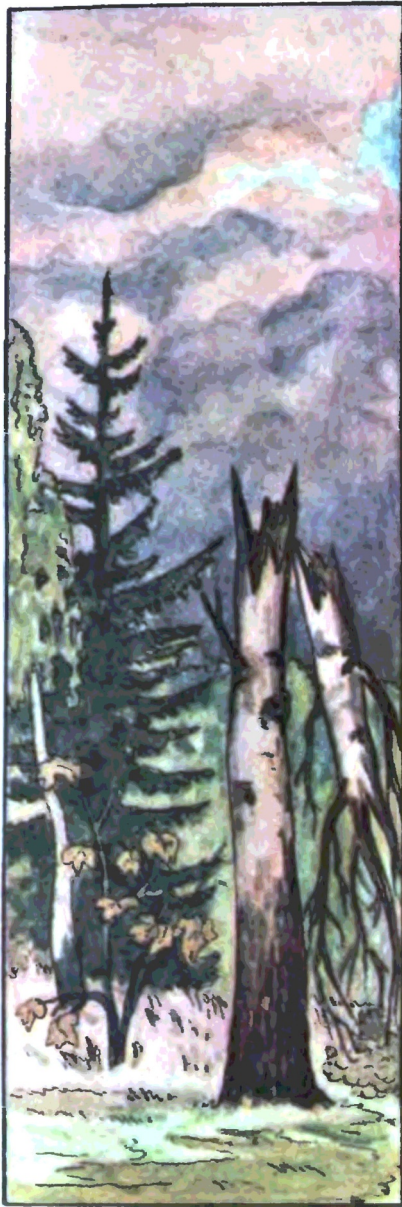
55 What can a person determine by looking at an airplane trail in the sky?



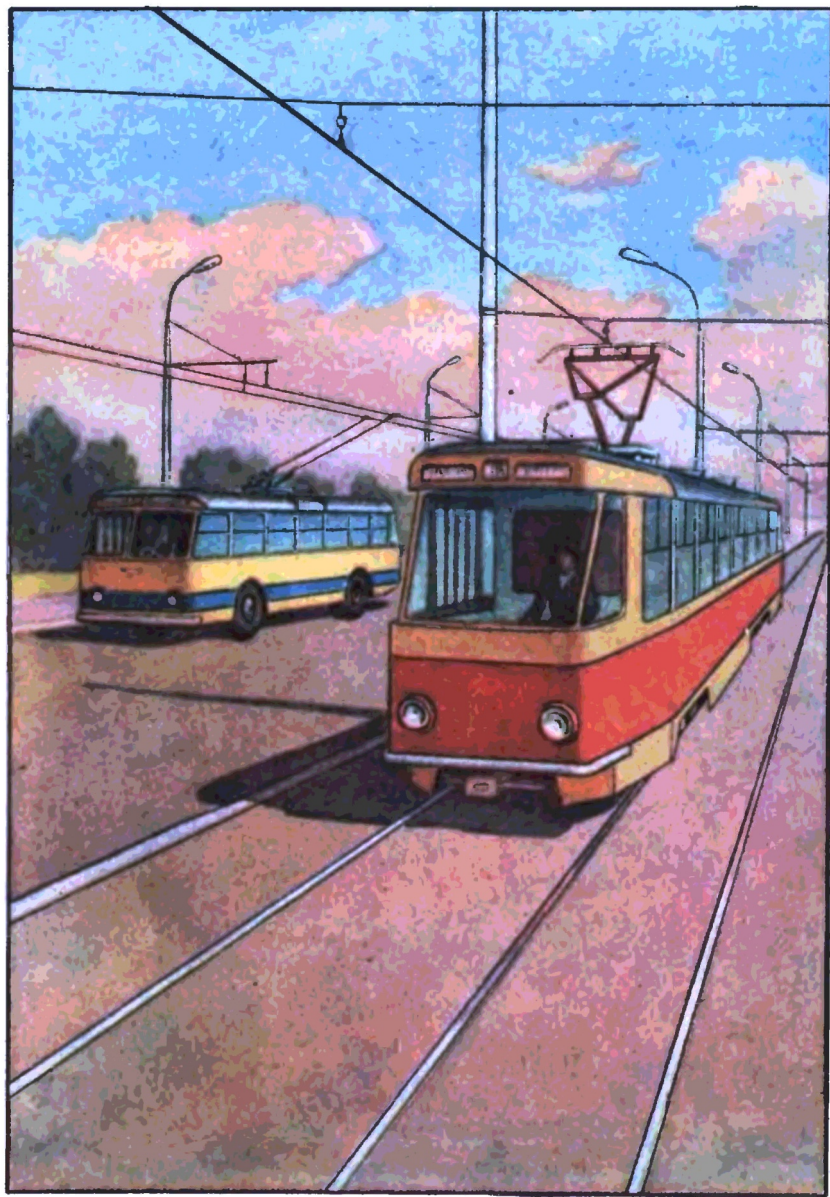
At what time of year do experiments with electricity
56 succeed better? Why?



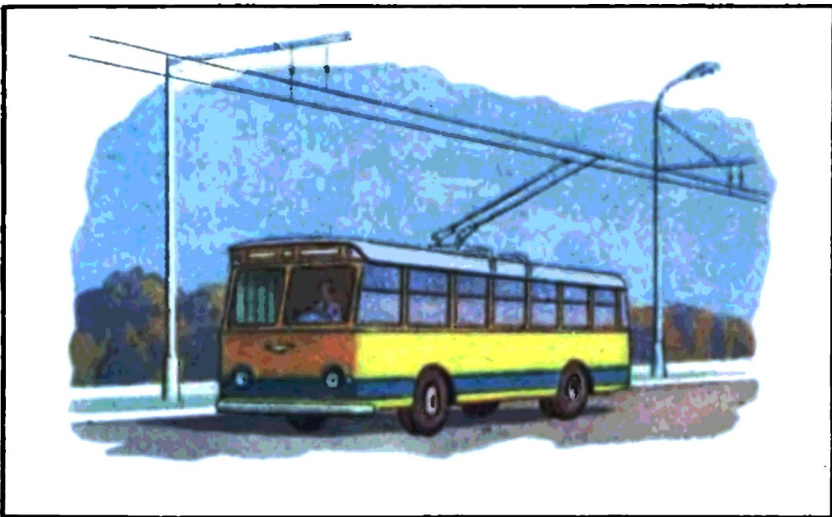
Which person is exposed to less danger during a
57 thunderstorm?



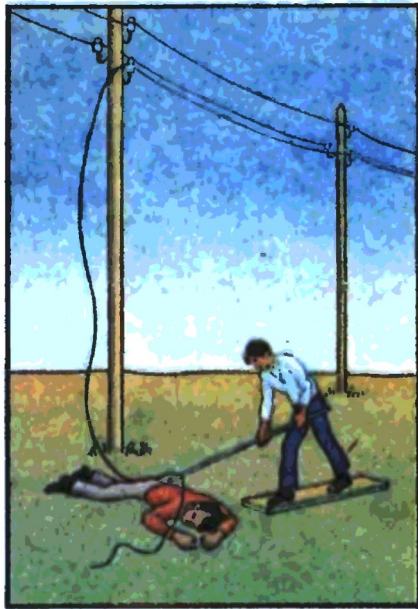
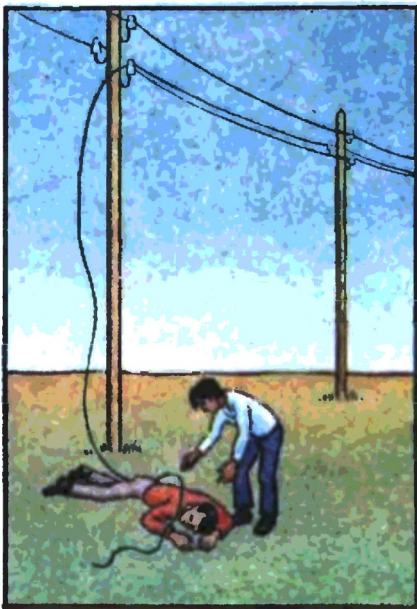
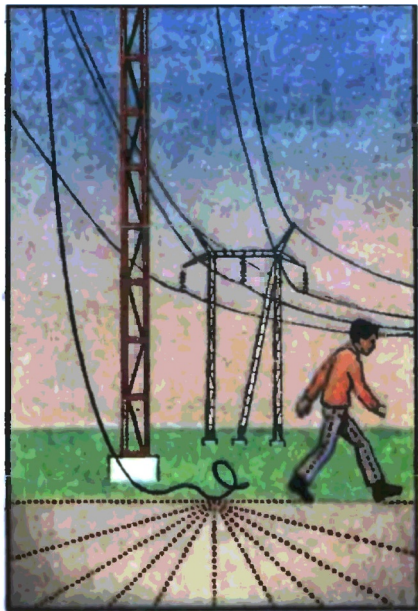
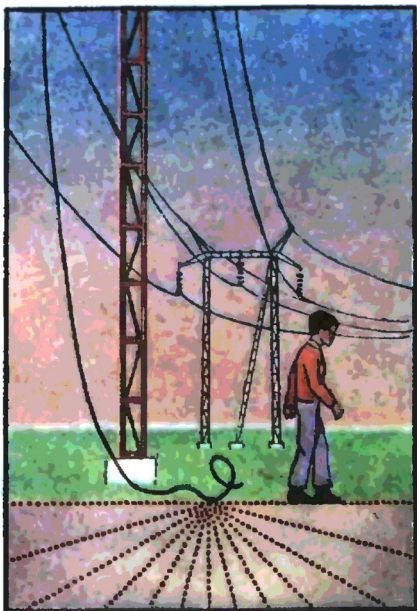
How can the differing damage to tree trunks caused
58 by lightning be explained?



Why do tram and trolleybus lines have a different
59 number of current-carrying wires?



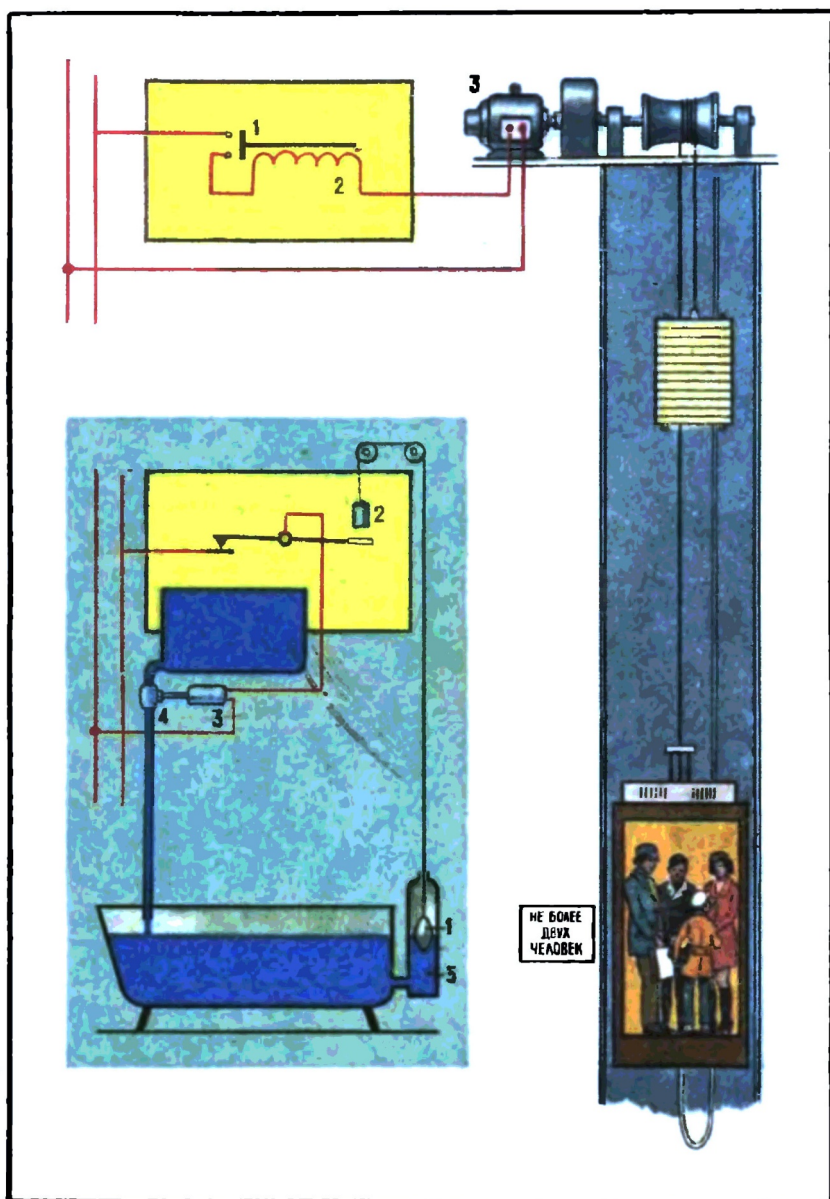
60 How do the current-carrying wires interact with each other in the upper and lower drawings?



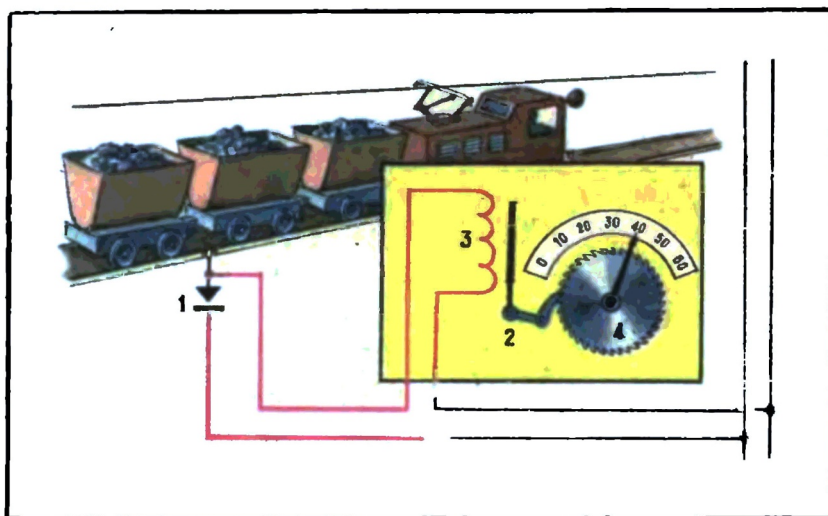
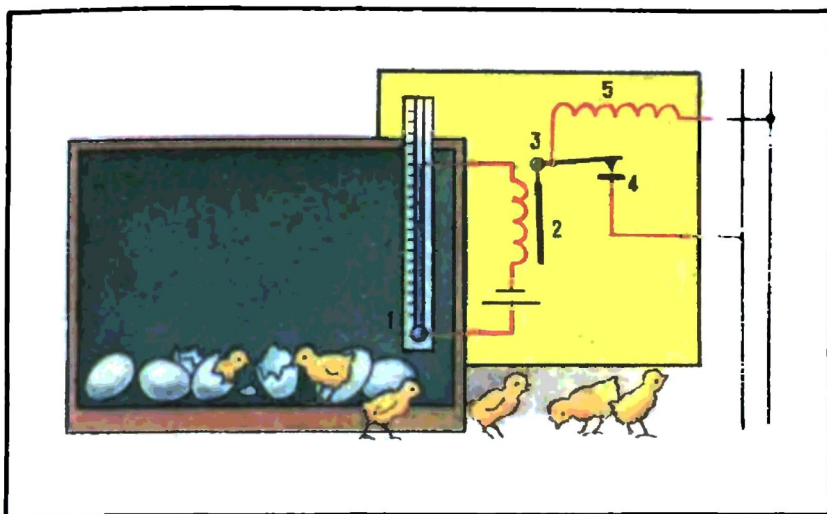
61 With what kind of steps should one leave the danger zone near a mast where a broken wire has fallen to the ground?



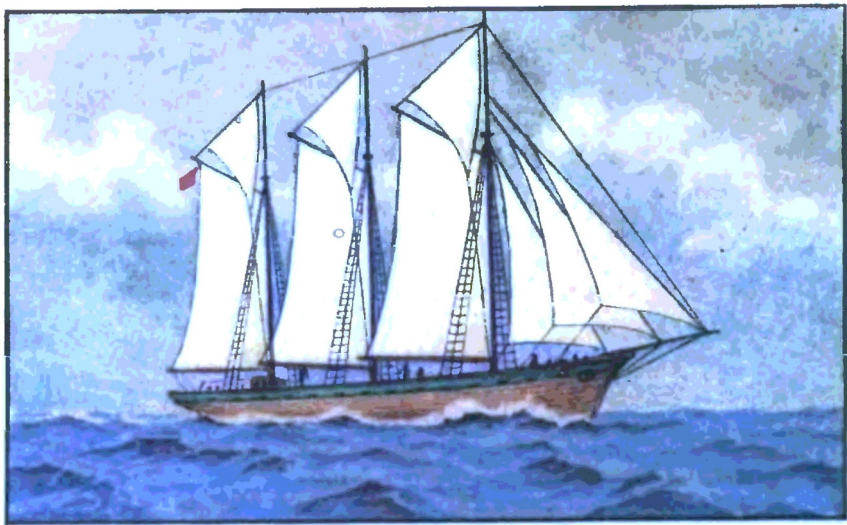
62 Is it possible to determine the line voltage by the number of insulators in a string?



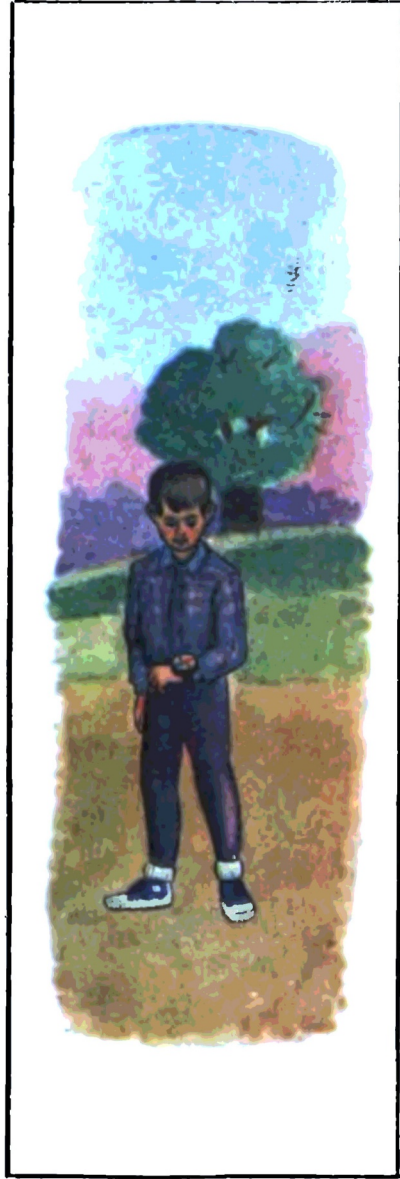
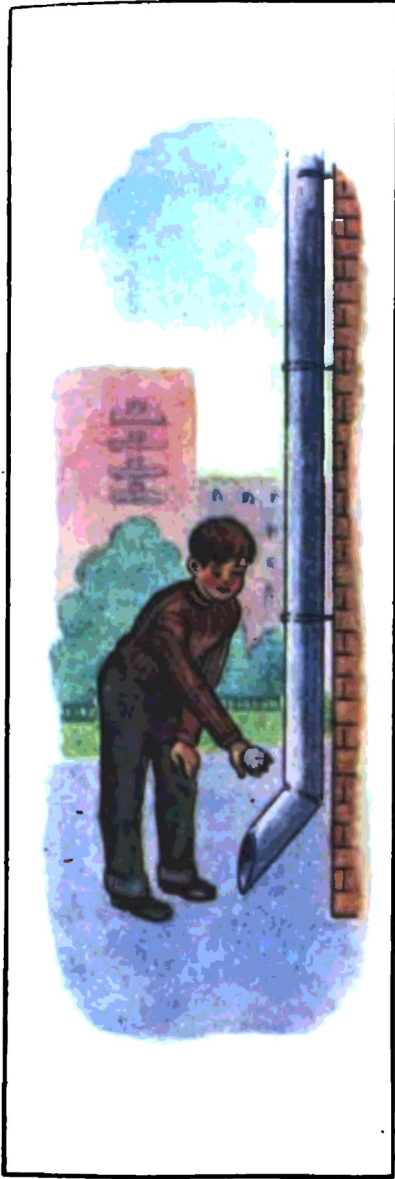
What physical phenomena are used in the operation of a relay? Explain the action of the relays shown.



64 Explain the action of each of the depicted relays from a physical point of view.



On which of these ships will the results when
65 studying the Earth's magnetic field be more accurate
and why?



For which of the two boys will the compass be more
66 accurate? Why?



67 In which of the depicted cases does the electric machine in the same electric locomotive act as a generator, and in which as an electric motor?

Answers

1. The athlete swimming near the bank will be the first to reach the finish line, as the river's current is slower there due to the friction of the water against the bank.

2. The drawings show the manifestation of inertia. In the top drawing, the bicycle abruptly stops its horizontal motion, and the person, by inertia, continues this motion and falls to the ground under the force of gravity. (The rear wheel of the bicycle also continues to move, which is why the bicycle tips over.) In the bottom drawing, when the boat suddenly starts moving, the person falls because, by inertia, they maintain a state of rest.

3. The operation of the grain thrower and the belt water lifter is based on the phenomenon of inertia. In the grain thrower, the grain is carried along by the conveyor belt and gains high speed. At the upper pulley of the conveyor belt, as the direction of the belt changes, the grain continues its straight-line motion by inertia, and then, under the influence of gravity, falls to the ground at a distance of up to 10 m from the conveyor.

In the belt water lifter, the upper block 1, driven by the electric motor 2, transmits motion to the belt 3, which picks up a layer of water held on it by molecular forces and lifts it to the upper block. When the belt turns, the water, by inertia, continues to move in its previous direction and, upon hitting the casing 4, flows into the chute 5.

4. The greater the mass of the trolley, the greater its inertia. From this, it is clear that it is more difficult to stop a loaded trolley (just as it is to move it from a stand-still).

5. At the moment of pushing off (before starting the jump), the boy in both cases exerts the same force on the boat, directed away from the bank. Under the influence of this force, the lighter boat will start to move faster, which makes it more difficult for the boy to jump to the bank.

6. In ball bearings, pressure is concentrated at the points where the balls contact the race. In cylindrical roller bearings, it is distributed along the entire line of contact between the roller and the race. Therefore, roller bearings are used in wagons with a mass exceeding 10 tonnes.

7. Vehicles lose traction when the force of friction between the wheel and the road surface is insufficient to provide grip. In turn, the force of friction between the wheel and the road is greater when there is more pressure on that wheel, determined by the weight of the vehicle and its load.

Vehicles 1 and 3 do not lose traction because their load is pressing down on the rear wheels; vehicles 2 and 4 lose traction because there is insufficient pressure on their rear wheels.

8. The weight of a body on the Moon is 6 times less than on Earth. Consequently, the force of pressure on the axles

of the Lunokhod's wheels is also 6 times less on the Moon than on Earth, so the frictional force between the axle and the wheel is also less.

9. The boy lying on the ice is acting correctly. He has distributed his weight over a larger area of the ice, thereby reducing the pressure on it. For the boy standing on skates, the area of the skate blades is small, and the pressure he exerts on the ice is high, so the ice could break.

10. A lorry has more wheels in order to reduce the pressure on the road surface.

11. A fuller tanker creates a greater downward force on the rails. The force of friction is proportional to the downward force. Therefore, when a full tanker is in motion, there is greater friction between the wheels and the rails.

12. The pressure on the bottom of the barrels does not depend on the diameter of the tubes inserted into them, but on the height of the liquid column in them, which is the same. Therefore, the pressure on the bottom of the barrels is the same.

13. Water flows from a tap under the action of pressure, which is proportional to the height of the water column above the tap. Consequently, the glass will fill with water more quickly in the left-hand drawing, as the speed at which the water flows out is greater here due to the higher

pressure.

14. Birds feel the same at different altitudes. The bones of birds are filled with air that communicates with the lungs. Under their skin, birds have air sacs, which also communicate with the lungs. When a bird ascends to a high altitude where the atmospheric pressure decreases, some of the air from its bones and air sacs is expelled through the lungs, and the internal air pressure becomes equal to the external pressure.

15. Knowing that for every 12 m of ascent, the atmospheric pressure drops by approximately 1 mm Hg relative to sea level, and using the barometer readings, we find that the height of the mountain is ≈ 1080 m, and the depth of the metro shaft is ≈ 60 m.

16. Using the remarks from problem 15, we get that the barometer on the mast will show ~ 715 mm Hg, which corresponds to $95,295$ Pa ≈ 95.3 kPa, and on the hot air balloon ~ 677 mm Hg ($90,230$ Pa = 90.2 kPa).

17. It is harder to pull a root vegetable out of damp clay soil because it is denser. To pull out a root vegetable, one must overcome the force of friction between the root and the soil. In addition, when pulling a root vegetable out of clay soil, a rarefied space is created underneath it, and the atmospheric pressure, not balanced by pressure from below, presses down on the root with great force, which also must be overcome.

18. The weight of the barrels is the same; based on the condition of floating bodies, the weight of the log in one of the barrels is equal to the weight of the water it displaces. The pressure of the water on the bottom is the same, as the water level in the barrels is the same.

19. In the left-hand churn, the hydrometer (lactometer) has sunk to a greater depth, therefore, the density of the milk in this churn is less than in the right-hand one. This means that this milk has a higher percentage of fat.

20. It is easier to lift a bucket of water at the moment when it is below the water level in the well, as it is acted upon by a buoyant force.

21. To surface, the diver stopped pressing his head against the valve in his helmet, which is designed to release exhaled air. The volume of the diver and his suit increases, and the buoyant force begins to grow. As soon as the buoyant force becomes greater than the force of gravity, the diver will surface.

22. Before us is a simple, self-regulating system (an automatic device). As soon as the water level in the drinkers decreases, according to the law of communicating vessels, the water level in the vessel with the float will also decrease. The float will lower, and by the principle of a lever, the valve will rise, and water from the mains will begin to flow into the drinker. Upon reaching a certain water level in the drinker, the float will rise under the action of Archimedes' principle, and the valve will again

close the opening in the water supply.

23. The submarine should be lowered onto a rocky bottom. In this case, the submarine will surface, as there will be water beneath it, creating a buoyant force equal to the difference between the pressure force on the lower and upper surfaces of the submarine. If the submarine is lowered onto clay soil, there will be no water between the submarine and the ground, and therefore no buoyant force can be generated.

24. In space, a person is in a state of weightlessness, while underwater (in a pool), they are in a state of equilibrium. In the first case, the astronaut is acted upon only by the force of gravity. In the second, along with the downward force of gravity, there is the upward Archimedean force; these two forces are balanced. Despite the external difference, the physical essence of the states is similar. This is why water pools are often used for training astronauts who are preparing for a spacewalk.

25. The artist's mistake is that in all positions, he has depicted the weather balloon with the same volume. However, as the balloon ascends, its volume increases; this increase can be quite significant. This is because as it gains altitude, the external atmospheric pressure on the envelope decreases (see problems 15, 16). Consequently, the gas inside the balloon expands, increasing its volume until the internal pressure equalises with the reduced external pressure. (The change in the balloon's volume due to a decrease in temperature is to be disregarded.)

26. In both cases, the work done by the pumps is the same. This is because the weight of a floating body is equal to the weight of the liquid displaced by its submerged part. This means that one can mentally replace the barge (or boat) that has entered the lock with the volume of water it displaces. Consequently, the work done by the pumps is determined not by the presence or absence of floating bodies in the lock, but by the difference in water levels between the upper and lower bodies of water (in both cases, this difference, H , is the same).

27. In the first case, the horizontal distance from point O to the load (the lever arm) is less than in the second case. Therefore, the lifting capacity of the crane is greater in the first case.

28. In the upper drawing, the icebreaker rides up onto the ice surface and breaks the ice sheet from above under its own weight. Here, the ice is broken using the potential energy the icebreaker gains as its bow is lifted. In the lower drawing, the ice field is broken by the kinetic energy of the icebreaker, which cuts through the ice due to its significant speed.

29. The load L is moving along with the aeroplane; therefore, relative to the floor of the aeroplane, it has neither kinetic nor potential energy. Relative to the Earth's surface, this load has both kinetic and potential energy.

30. By taking a run-up, the boy will jump further because

in this case his kinetic energy will be greater (it is the sum of the energy gained from the run-up and the energy gained from pushing off the ground).

31. In the lowest position B, the kinetic energy of the moving swing is at its maximum. As the swing rises to point C or A, kinetic energy is converted into potential energy. During the return movement of the swing, potential energy is converted back into kinetic energy. The kinetic energy of the running boy is partially converted into potential energy during the jump. In the process of landing, the acquired potential energy is converted back into kinetic energy. At the end of the landing, the kinetic energy is converted into internal energy.

32. Drawings 1 and 2 depict high tide and low tide. The cause of tides is the gravitational attraction of other celestial bodies, mainly the Moon, on the Earth's hydrosphere. Drawings 3 and 4 show a tidal power station. In the USSR in 1968, such a power station with a capacity of 800 kW was built in Kislayà Guba on the Kola Peninsula. The generation of electricity at this station is based on using the energy of water that moves during high and low tide. During high tide, water flows from the sea into a basin and drives the turbine blades; during low tide, the water returns from the basin to the sea and again rotates the turbine blades. During high tide (Fig. 3), the potential energy of the water is converted into the kinetic energy of the rotating turbine and generator rotor,

where it is then converted into electrical energy.

33. Steam, gas, and other pipes are never rigidly fixed; they rest freely on supports. To protect the pipes from breaking due to thermal expansion, compensators are often used, which can be made in the form of a bent pipe loop. During thermal expansion, this loop acts as a spring and compresses, compensating for the increase in length, which prevents the pipe from rupturing.

34. The left drawing was made in winter. The weights have moved upwards, which is due to the shortening of the current-carrying wire as the temperature decreases. The right drawing was made in summer. Here, the current-carrying wire has lengthened due to thermal expansion.

35. The thermal conductivity of ice is four times greater than that of water, so it is warmer for geese in the water.

36. It is warmer in a wooden house because wood contains 70% air, whereas brick contains 20%. Air is a poor conductor of heat. More recently, "porous" bricks have been used in construction to reduce thermal conductivity.

37. To protect crops from freezing in winter, snow retention and snow accumulation are used. Crops die from freezing when the soil temperature at a depth of 3 cm remains at or below -20°C for a prolonged period. The thermal conductivity of snow cover is 8 to 10 times lower than that of soil, so snow protects overwintering plants from freezing. The temperature at the soil surface under the

snow does not drop below -4°C . Snow retention helps to maintain soil temperature and also promotes the slow melting of snow, which increases moisture reserves in the ground.

38. The direction of smoke depends on the direction of convection currents in the air. During the day, the soil in a field is heated by the sun much more intensely than in a forest, where most of the sun's rays are absorbed by trees. Consequently, convection currents move from the forest to the field, creating wind. At night, the field cools down more quickly, and the cool convection currents move from the field to the forest.

39. For the boy lying on the sand, energy is transferred from the sun by radiation and from the sand by conduction. For the boy sitting by the stove, energy is mainly transferred by conduction.

40. Perishable goods are transported in railway wagons painted white, as such a wagon is heated to a lesser extent by the sun's rays.

41. During a rocket's flight, its surface temperature increases due to aerodynamic heating and solar radiation. At an altitude of 15 km (Fig. 1), aerodynamic heating occurs due to the significant compression and heating of the air in front of the moving rocket and friction between the air and its skin. As the altitude increases to 110 km (Fig. 2), the air density decreases, and the rocket's heating is primarily caused by solar radiation.

42. To avoid overheating from the Sun's radiation in space, an astronaut wears a white suit. The astronaut lands in an orange suit so that they can be quickly spotted.

43. It is colder for flying birds. During flight, a bird's feathers are pressed tightly against its body, and cold air rushes past, stripping away internal energy. This energy loss can be so great that birds freeze in mid-air. For stationary birds, the air trapped between their fluffed-up feathers acts as an insulator, protecting them from the external cold.

The near-freezing temperature of animals' paws is vitally important for them. If the temperature of their paws were above zero in winter, the snow beneath them would melt and the animals would freeze to the spot. Furthermore, the fat in their limbs has a much lower solidification temperature than the fat inside their body, which also protects their paws from freezing in winter.

44. In a severe frost, trees and wooden structures creak because the water that has collected in their cracks during rain or thaws turns into ice. Ice occupies a larger volume than water, causing it to split the wood.

45. Snow will melt faster in a field. In a forest, few of the sun's rays penetrate through the trees, meaning the air temperature is lower and snow takes a long time to melt. The ground will freeze to a greater depth in a field because much more snow accumulates in a forest over the winter. Furthermore, in a forest, the snow settles on a layer of

leaves rather than directly on the soil. This covering insulates the soil in the forest and protects it from freezing.

46. An ice crossing that has been cleared of snow is more reliable because snow is a poor thermal conductor. When snow is removed from an ice crossing, the ice is cooled by the cold air and becomes thicker. It has been established that for a vehicle with a mass of 1.5 tonnes, a crack-free ice thickness of at least 15 cm is required, and for a 3-tonne vehicle, the ice must be 24 cm thick, and so on. It is not uncommon for floods to be more severe in winters with little snow, as the exposed ground freezes more deeply and does not have time to thaw by spring, causing meltwater to collect on its surface.

47. The air temperature will rise where it has started to snow. The formation of snow crystals (snowflakes) is associated with the release of the latent heat of fusion.

48. It will feel colder to an observer near a river because as ice melts, it absorbs a large amount of heat from its surroundings.

49. In a garden that has been watered, the soil will freeze to a lesser depth than dry soil. This is because as the water in the moist soil freezes during winter, the latent heat of fusion is released, which slows the freezing process and reduces the overall depth of the frost.

50. A path will remain damp for longer in a deciduous forest because deciduous trees transpire approximately 8

to 10 times more water than coniferous trees, making the air more humid. Furthermore, the temperature in a deciduous forest is lower than in a coniferous one because by evaporating more moisture, the leaves absorb a greater amount of heat from the surrounding air.

51. The boy feels the cold more intensely because the wind more quickly carries away the layer of air warmed by his body. At the same time, the wind increases the rate of evaporation of moisture from the surface of his skin, causing a further cooling effect.

52. The difference in the longevity of the bubbles is due to air humidity. If the humidity is low, the thin walls of the bubbles dry out quickly and burst. In humid air, however, evaporation from the bubble walls is slower, and they last much longer.

53. Sprinkling plants when there is no wind protects them from morning frosts and increases the humidity of the air. As the temperature subsequently drops, water vapour begins to condense as fog or dew, a process that releases the latent heat of vaporization, which in turn raises the temperature of the surrounding air. Moistening the soil increases its thermal conductivity (by 30% or more), which increases the flow of internal energy from deeper soil layers. When the temperature drops, ice forms on the surface of the wet plants. The formation of ice is accompanied by the release of the latent heat of fusion.

54. The boiling point of a liquid depends on atmospheric

pressure. On a mountain, the atmospheric pressure is lower than at sea level, so water will boil at a lower temperature. In a mine, the boiling point is higher due to the increased atmospheric pressure. To determine the height of a mountain or the depth of a gorge, the following data can be used:

1. The boiling point of water changes by 3°C for every kilometre of altitude relative to sea level.

2. A table showing the change in boiling point at various atmospheric pressures, knowing that for every 12-metre increase in altitude, the atmospheric pressure drops by 1 mmHg relative to sea level:

$101^{\circ}\text{C} - 787.7 \text{ mmHg} = 104,985 \text{ Pa} = 105.0 \text{ kPa}$

$100^{\circ}\text{C} - 760 \text{ mmHg} = 101,292 \text{ Pa} = 101.3 \text{ kPa}$

$98^{\circ}\text{C} - 707 \text{ mmHg} = 94,229 \text{ Pa} = 94.2 \text{ kPa}$

$96^{\circ}\text{C} - 657.7 \text{ mmHg} = 87,658 \text{ Pa} = 87.6 \text{ kPa}$

$94^{\circ}\text{C} - 611 \text{ mmHg} = 81,434 \text{ Pa} = 81.4 \text{ kPa}$

$92^{\circ}\text{C} - 576 \text{ mmHg} = 76,769 \text{ Pa} = 76.8 \text{ kPa}$

$90^{\circ}\text{C} - 525.5 \text{ mmHg} = 70,038 \text{ Pa} = 70.0 \text{ kPa}$

$88^{\circ}\text{C} - 487 \text{ mmHg} = 64,907 \text{ Pa} = 64.9 \text{ kPa}$

55. The similarity between the phenomena shown in the pictures is that in both cases, condensation of vapour occurs, forming a mist or fog. When room air is cooled, some of the vapour condenses on dust particles, creating a fog. At high altitudes, the air is saturated with water vapour. Behind an aircraft, exhaust particles from the engine become condensation nuclei for this vapour, which promotes the formation of fog and the appearance of a

white trail (contrail). This trail can be used to detect the aircraft from a great distance and to determine its approximate altitude, speed, and flight path. The cloud-like trail also makes it possible to determine the speed and direction of air currents.

56. Electrical experiments are more successful in winter, especially during a severe frost, because the air is drier and therefore a better electrical insulator. In autumn, the humidity of the air increases, causing a very thin film of moisture to form on the surface of objects, which allows electrical charge on instruments to dissipate quickly.

57. Lightning can occur between clouds, or between a cloud and objects on the ground. In the latter case, the electrical charge in the cloud induces an opposite charge on the Earth's surface below, particularly on tall objects. For this reason, it is advisable during a thunderstorm to take shelter under a small bush or in a depression, but not under a tall tree.

58. Different parts of a tree trunk have different levels of electrical resistance. The heartwood of deciduous trees has a lower resistance than its bark and the layers beneath it. When lightning strikes such a tree, a strong electric current passes through the low-resistance heartwood, causing the sap to boil. The resulting steam, under immense pressure, bursts the trunk from the inside. Conversely, the resinous heartwood of coniferous trees (like spruce and pine) has a higher resistance than the outer layers, so the current from a lightning strike tends

to travel down the outside of the trunk, damaging the surface.

59. A trolleybus uses two overhead wires. Current flows from one wire, through a current collector into the electric motor, and returns to the substation through a second current collector on the second wire. A tram, however, draws current from a single overhead wire via a pantograph or bow collector. The return path for the current is through the tram's metal wheels and the rails, which are grounded.

60. In the parallel supply wires for a railway, the current flows in the same direction. In this case, the interaction of the magnetic fields from the currents causes the wires to be attracted to each other. In the two wires above a trolleybus, the current flows in opposite directions. This interaction causes the magnetic fields to repel the wires from each other.

61. One must exit an area of current dispersal by taking small, shuffling steps. If an overhead power line breaks and touches the ground, the electric current will spread out over a wide area around the point of contact. When a person steps into this area, a potential difference develops between their feet. This is known as step potential or step voltage. As a person moves further away from the point where the wire touches the ground, the step potential decreases, reducing the risk of electric shock.

In Figure 3, the person is endangering themselves. In Figure 4, the person is correctly rescuing the victim from

the electric current, because the dry stick and the wooden board are poor conductors of electricity and act as insulators.

62. Yes, it is possible. The approximate relationship between the voltage of a line and the number of insulators in a string is shown below:

Voltage (kV)	Number of Insulators
35	3
110	7
150	9
220	13
330	17

63. An electromagnetic current relay is used to protect an electric motor from overloads. This type of relay is connected in series with the motor's circuit. When the current exceeds a predetermined limit, the magnetic field produced by the coil (2) becomes strong enough to move the armature (1). This movement automatically opens the circuit, protecting the motor (3) from overheating and damage.

64. When the air temperature in an incubator rises above the desired level, the mercury column in the thermometer (1) expands and closes the circuit of a thermal relay. The resulting magnetic field from the electromagnet (2) pulls in a lightweight armature (3). This action opens the main circuit at point (4), cutting power to the heating coil (5) that warms the air. In this way, the thermal relay

regulates the temperature within the incubator.

A mechanical relay counts the number of ore carts leaving a quarry. It operates when a cart's wheel presses down on a contact (1), closing the relay's circuit. When the circuit is closed, the light armature (2) of the electromagnet is drawn into the coil (3), which in turn actuates the mechanism of the counter (4).

65. Any investigation of the Earth's magnetic field conducted on a wooden sailing ship will be more accurate because wood does not become magnetised. A metal ship, on the other hand, does become magnetised by the Earth's magnetic field, and for this reason, such studies are not carried out on them.

66. For the boy standing near the iron pipe, the compass reading will be inaccurate, as the iron pipe will deflect the compass's magnetic needle away from the magnetic meridian. The compass reading for the boy on the right is more accurate, as there are no metallic objects near him.

67. When a train descends a hill, its potential energy is converted into kinetic energy. The electric motor of the locomotive, acting as a generator, converts part of the train's kinetic energy into electrical energy and feeds it back into the overhead power lines. This process is known as regenerative braking. When the locomotive is climbing a hill, the same machine functions as an electric motor, converting electrical energy into the mechanical energy needed to move the train.

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